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## THROUGH THE EYES OF THE EDITOR

Michael S. Matson discusses the functions of immediate dentures and describes a practical technique for duplicating the form of the mucous membrane in detail. The results of the procedure appear to be excellent. He also describes the surgical procedures used at the time the denture is inserted and makes suggestions about the subsequent service to the patient.

Howard B. Johnson describes a packing technique suggested by Irving R. Hardy for coloring acrylic resin denture bases to simulate living tissues. The procedure is a modification of the technique suggested by Earl Pound and a slight modification of the routine packing procedures. It offers certain advantages over other denture base color characterization methods and is simple enough to be practical.

John P. Frush and Roland D. Fisher discuss esthetics of dentures in relation to the sex of the patient. It does seem logical that there should be characteristics of the color, form, size, and arrangement of teeth which would correspond with the masculinity or femininity of patients. There is no doubt that there are too many dentures made with "perfect teeth [arranged] into precise, straight incisal lines and radially perfect long axes," but many dentists do more than this for their patients. It is to be hoped that many more dentists will be stimulated to give more consideration to the development of better esthetics for their patients. In this article, the authors describe the feminine and the masculine characteristics of teeth, and show how these characteristics can be expressed in the dentures. The techniques are simple, and some of them have been widely used, but in this concept of esthetics, they are used with a planned objective.

Kenneth P. Austin discusses diagnosis and treatment planning for complete denture patients. He indicates the various things that should be observed and considered as the patient is being examined. If the procedures he suggests are properly carried out, much trouble can be avoided.

Charles L. Bolender discusses the significance of vertical dimension in prosthetic dentistry. He relates the practical aspects of the problem to the anatomy and movements of the structures involved. This essay won the second prize in the essay contest for senior dental students sponsored by the American Denture Society. He is to be congratulated for his success.

Robert E. Moyers discusses the neurophysiologic factors which regulate the various jaw positions and movements. He gives an understandable description of the neuromuscular system involved. He classifies the physiologic rest position as "the postural position of the mandible" and objects to the term, physiologic rest position. While it is obvious that the involved muscles are not *completely* at rest, they are, as a group, more nearly at rest than at any other time. Certainly tonic contraction is a physiologic process even though it results in a postural position of the mandible. His criticism of the term does not seem to be valid. He states that the postural (physiologic rest) position is the first to be developed in the infant, and that centric relation is established when the deciduous teeth erupt into occlusion. His definition of centric relation is probably correct from the standpoint of the physiologist, but it is of little value to the prosthodontist, except that it emphasizes the importance of developing a centric occlusion in harmony with centric relation. He recognizes centric posi-

tion as *one position only* and that all other positions are eccentric positions. It is important to note that occlusal disharmonies can cause patients to close into certain eccentric positions repeatedly, but that these positions cannot be interpreted as centric position. The neuromuscular reflex system is more accurate in a dentition than with dentures. There is a greater number of impulses being set up by stimuli arising from the periodontal membranes than by stimuli arising from the denture-bearing mucous membrane. In time, the memory of the acquired neuromuscular reflex pattern is lost, and dentures constructed to the eccentric position no longer conform to the basic neuromuscular pattern established in infancy.

Arthur R. Frechette reports on his studies of the influence of partial denture design on the distribution of occlusal forces to the abutment teeth. The testing procedures are well worked out, and the results should be of value in planning partial dentures. This is true even though many factors which must be considered in the mouth could not be included or duplicated in this study. More work of this fundamental nature is indicated.

Robert N. Phillips describes a method for retaining distal extension partial lower dentures which places the fulcrum line anterior to the most distal abutment tooth. This protects the posterior abutment from excessive occlusal stress. This essay won the first prize in the essay contest for senior dental students sponsored by the American Denture Society. He is to be congratulated for his success.

Louis Alexander Cohn discusses the physiologic aspects of the anchorage of fixed and removable partial dentures. He favors solid fixation of abutment teeth and de-emphasizes the importance of individual tooth movement. The advantages and disadvantages of various types of attachments for restorations are clearly stated, and he shows roentgenographic evidence to support his analyses of the factors involved.

Leo Talkov describes three techniques for making copper-band splints for temporary restorations. The procedures involve the use of autopolymerizing acrylic resins re-enforced by copper bands. These restorations are simple to construct by any of the techniques and seem to have advantages over some other types of temporary restorations.

Nathan Lewis Dubin discusses occlusal rehabilitation and concludes that it is simply the practice of good dentistry. This is another way of saying that the dental mechanism should be treated as a whole rather than to treat the individual defects as separate entities. There can be little doubt that this concept of the practice of dentistry is one of the great advances toward the ideal in restorative dentistry. The repair of individual teeth without due consideration for the present and future health of the other parts of the stomatognathic system is rapidly becoming inadequate and obsolete dental treatment. There are differences of opinion regarding the techniques of this all-inclusive concept, but the objective is the same—a totally healthy mouth. A loss of occlusal vertical dimension is listed as one of the indications for occlusal rehabilitation. There is ample evidence that increasing this vertical dimension is fraught with danger, and that if the occlusal vertical dimension is increased beyond the physiologic tolerance, greater damage will result to the patient than if nothing was done. The Transograph is recommended as the instrument that makes effective occlusal rehabilitation possible. It should be pointed out that the instrument is not the key to successful treatment. It requires knowledge, skill, and integrity on the part of the dentist in order to render the best service to the patient, regardless of the instruments used. The statement, "There is no rigid axis between the two condylar elements [of the Transograph]; they act independently of each other as do the condyles in the head." must be challenged on two counts. First, the upper member of the instrument is a solid, irregularly shaped but *inflexible* unit which makes *independent* movement of any part of it impossible. The same is true of the lower member of the instrument. When any part of either the upper or lower member of the instrument is moved, a related movement occurs in *every* part of that member of the instrument. If a single part of the instrument is the rotation center for a movement, that point moves by rotation. Second, the mandible is quite rigid from one condyle to the other. This precludes any possibility of movement occurring in one part of the mandible without a related movement occurring in *all* other parts of the mandible. The accurate location of the "hinge axis" cannot be criticized, but a harder material than

wax (such as plaster of Paris) might be an improvement in the registration of interocclusal records. The importance of orienting the casts on the articulator with reference to cranial landmarks seems to be overemphasized. Assuming an axis in the mouth and on the articulator, it is necessary only to make the *relation* to the axis identical in each instance. All other factors are then relative to these axes. The arbitrary setting of the "jaw movement guide assembly" does not seem logical for all patients, and a failure to take into consideration the effect of the condyle path on jaw positions other than centric position indicates that no consideration is given to occlusal balance in other than centric position. Facets worn on teeth indicate that occlusal contacts are made in other than centric position in most mouths. Harmony in the occlusion should be developed in eccentric occlusions as well as in centric occlusion.

Louis J. Regan discussed the various legal aspects of the dentist-patient relationship. He listed the responsibilities of dentists under the law and showed how dentists may become involved in suits resulting from complaints made by patients. Particular notice was called to those situations involving prosthodontics. Several suggestions were made regarding the functions and activities of grievance committees. It is apparent that dentists and especially prosthodontists have not provided themselves with sufficient protection since they have risks of which they have not been aware.

Robert B. Welden and John V. Niiranen describe their technique for adapting and fitting a stock acrylic resin for a patient. The necessary preparation and impression procedures are discussed as are the technical operations involved. It is obvious that the dentist is capable of performing this service for patients on account of his experience and training in handling the materials used.

*—Carl O. Boucher*

# THE SIX FUNCTIONS OF TISSUE DUPLICATING IMMEDIATE DENTURES

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IMMEDIATE DENTURE PROCEDURES have become an accepted part of dental practice. The profession is well aware of the benefits to be obtained from the use of this type of prosthetic restoration. The important advantages of immediate dentures are: (1) The patient is not edentulous during the healing process. (2) The appearance of the face is not as severely affected. (3) The patient will not procrastinate about the removal of infected teeth. (4) The surrounding structures are better maintained. (5) Additional comfort is obtained from the protecting action of the denture. (6) The supporting structures have more stability and greater tissue resiliency. (7) There is improved natural esthetics.

To be effective, immediate dentures should provide a duplication of the anatomic structures to be covered or replaced by the polished surface of the denture (Fig. 11). This is necessary if the patient is to retain the following important functions: (1) mastication, (2) deglutition, (3) speech, (4) normal facial contour and expression, (5) health of the dental and supporting tissues, and (6) intrinsic esthetic values of the dental tissues.

## MASTICATION, DEGLUTITION, AND SPEECH

In mastication, the buccinator muscle and the tongue cooperate in keeping the food on the occlusal surface of the teeth. DeVan[5] quotes Kingery as saying that the teeth constitute only a third of the masticatory machine, that the other two-thirds consist of the tongue and cheeks. These muscle organs serve as steering agents in guiding, directing, and maintaining the food morsel between the teeth. As chewing proceeds, a slow backward movement of the chewed food takes place by progressive actions of the buccinator muscle and the tongue.

In speech, the influential factors are the teeth, the palatal vault, the contours of the alveolar ridges, the tongue, and the normal dimensions of the denture space.

## FACIAL EXPRESSION AND APPEARANCE

The functions of the superficial and deep muscles underlying the face are extremely important in maintaining the natural contours and expression of an individual. These muscles and tissues are supported by the hard structures—that is, by the teeth and the alveolar processes (or denture bases of the maxillae and mandible.

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### CONTOUR OF MUCOUS MEMBRANE AND TEETH

The intrinsic appearance of the mucous membrane and teeth is individual to the patient. Just as the patient has an individual complexion and facial contour, so is there also an individual complexion and contour to the mucous membrane and the dental tissues in his oral cavity. The shape of dentition, complexion of mucous membrane, and contour of the alveolar processes are particular to the individual.

### INTERRELATION OF TISSUES AND FUNCTION

It should be recognized that these tissues are interrelated and that a disturbance to their normal environment will in turn disturb their functions and health. As the individual character and proportions of the teeth and alveolar bone support the tissues of mastication, deglutition, speech, and the muscles of the face, it is evident that changing these proportions will cause a change in the functions of the tissues supported.

The technique to be described is simple to execute, and it will fulfill the objectives of immediate denture service and maintain their six primary functions.

Individual changes in the technique can be made at the discretion of the operator. However, the primary theory must always be kept in mind—namely, the tissues to be replaced or covered must be duplicated in the polished surface of the denture. The patient's remaining dentition is used to duplicate the dental tissues.

Fig. 1.—The cast on the left is not suitable for use because the impression was not extended to record the entire denture area. The cast on the right is satisfactory.

### THE IMPRESSION

A cardinal rule is that the soft tissues must not be distorted when preliminary or final impressions are made. Initial impressions of the patient's mouth are made before any surgery is attempted. The initial impression is made in an alginate material in a suitable tray. Adequate coverage of the labial surface of the ridge and of the tuberosities of the maxillae are of utmost importance (Fig. 1). In the lower jaw, the labial surface of the ridge, the mylohyoid region, and the retromolar pads must be included. These impressions are poured in stone to be used for (1) study casts, (2) the fabrication of perforated trays, (3) a record of the jaw relations, and (4) guides for the laboratory procedures and survery.

An accurate impression is obtained in an alginate impression material in a perforated shellac tray which is made over the study cast.

A maxillomandibular relation record is made for mounting the casts on an articulator.

### MARKING THE WORKING CASTS

The casts are poured in stone, and duplicate casts are made for reference. The maxillomandibular record is used for mounting both sets of casts. The casts are marked to indicate where and how much alveolectomy is required. In the posterior region, this is 1.5 mm. above the gingival margins; in the anterior region, it is 5 mm. above the gingival margins.

Overdeveloped tuberosities and mandibular tori are noted on the casts for trimming. The removal of these structures is sound procedure.

### SETTING THE TEETH

The teeth are removed individually from the stone cast, and denture teeth are adapted to replace them (Fig. 2). This must be done with care, as the character of the dental arch should be maintained. In setting the teeth on the cast, modifications may be desirable. It is of the greatest importance to make sure that the patient is in agreement with the proposed changes.

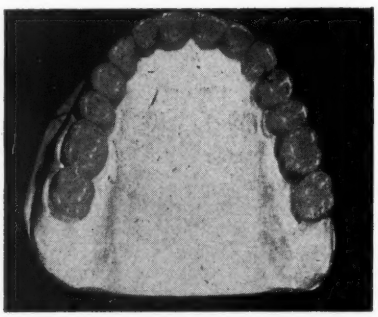

Fig. 2.—Artificial teeth have been adapted to the cast and waxed into position.

Desirable changes can be made safely if Gieler's[1] suggestions are followed. He advises that, in nature, irregularity of the anterior teeth seems to be the rule rather than the exception. This irregularity occurs without a classic pattern, varying with each individual. This does not mean that each irregularity and defect should be duplicated. Rather, that a careful study should be made of the main identifying features of the natural teeth, and that these be copied or altered to a greater or lesser degree depending on the kind and extent of the imperfections. It should be the aim of the dentist to avoid altering the individuality of the mouth except in those patients where change is desired.

Certain modifications, such as straightening of the line of occlusion, elimination of inclinations of the anterior teeth, and closure of the anterior spaces existing in the natural dentition, can be made if desired.

If additional refinements in the occlusal surfaces are desired, Van Victor's[2] method can be used to duplicate the anterior teeth.

### PALATE DUPLICATION

After all of the teeth have been placed in position on the stone cast, separating medium is applied to the palatal surface. Plaster is poured into this surface up to the height of the cervical margins of the denture teeth.

This mold is used to swadge a palate base from 20 gauge wax or from baseplate material of the same thickness. The swadging is done by pressing the heated wax or baseplate material between the palate mold and the palate of the stone cast. When the palate form is placed back on the stone cast, and waxed into position, it will duplicate the contours of the palate exactly (Fig. 3).

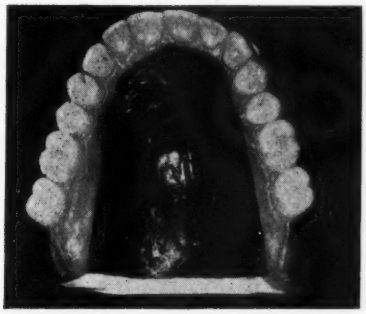

Fig. 3.—The wax pattern made from the cast of the palate is in place and luted to the wax holding the teeth.

### BUCCAL AND LABIAL DUPLICATION

The form of the buccal tissue is reproduced by making a mold of these surfaces. Tin foil is burnished against the cast covering the occlusal surfaces of the teeth and covering the reflections. The tin foil is burnished into place from the midline posterior to the distal end on each side.

Plaster is poured over the tin foil to form two molds (Fig. 4). One is made for each side of the cast. The tin foil will adhere to the hardened molds when they are removed. Softened 20 gauge wax is pressed between the mold and the buccal and labial surfaces of the cast. This wax and the tin foil will adhere to the cast. The tin foil is removed from the wax, and the wax is trimmed (Fig. 5). A wax form remains which is a duplicate of the form of the buccal and labial tissues.

The reflections are filled with baseplate wax and should be thick enough to provide an adequate border seal. This additional thickness in the border of the denture will make it possible to provide relief in the denture when this is necessary.

### PREPARATION OF THE LABIAL SURFACE OF THE CAST

To minimize the distortion of the lip due to the thickness of the labial flange of the denture, the labial surface of the cast is denuded of wax from cuspid to cuspid, to the height of the alveolectomy.

This exposed surface of the cast is covered with a thin layer of wax. The melted wax is applied with a fine camel's hair brush (Fig. 6). This wax provides a surface for stippling. Additional space for the labial flange is provided by the alveolectomy.

The denture pattern is waxed and stippled to give it the natural characteristics of the oral mucous membrane. It is now ready for flasking.

### TRIMMING THE CAST AND THE CONSTRUCTION OF THE SURGICAL TEMPLATE

The flask is opened after the wax pattern has been softened and washed out. The line of the planned alveolectomy is placed on the cast, and the ridge of the

cast is trimmed to this line. The ridge is shaped so it has rounded surfaces. The bulk of tissue to be removed surgically is removed from the cast.

The trimmed cast is duplicated, and a transparent surgical template is made over the duplicate cast. The surgical template is used as a guide for shaping the bone according to the individual plan of treatment (Fig. 7).

Fig. 4.

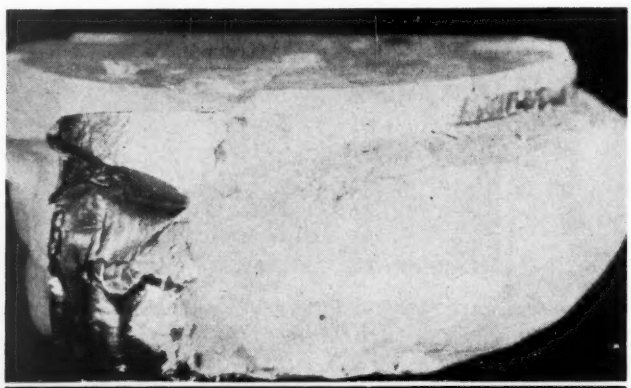

Fig. 5.

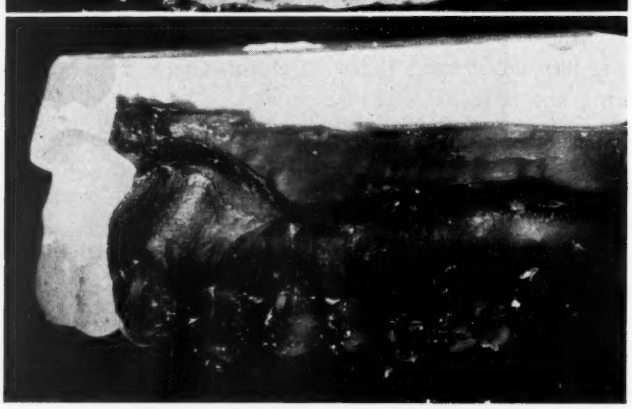

Fig. 4.—A plaster core has been formed over tin foil which was adapted over the cast and teeth. The core covers the reflections and is flush with the occlusal surfaces and incisal edges.

Fig. 5.—Sheet casting wax is swadged directly to the cast. The excess wax is to be removed later.

## COLOR CHARACTERIZING THE DENTURE BASE

The flask is packed with materials chosen to reproduce the natural hues of the mucous membrane. Several materials are available which will produce good color characterization. Individual preference is the guide in making a choice. Four of these are: (1) tinting materials* similar to those described by Pound[3]; (2) the color veneer portion of a Denture Veneer Package†; (3) denture base materials containing a suspension of varying colors‡; (4) paint-on color tints§.

*Kay See Dental Mfg. Co., Kansas City, Mo.
†Dentists' Supply Co., York, Pa.
‡Tilon; Ticonium, Albany, N. Y.
§H. D. Justi & Co., Philadelphia 4, Pa.

The first materials listed were used for color characterizing the dentures illustrated in this article. This method is the most time consuming, but the results are excellent (Figs. 8, 9, 10, 11.)

## THE LOWER DENTURE

The lower denture is constructed in the same manner as the upper denture. If deep undercuts are present on the lingual side of the ridge, they are relieved with tin foil or plaster before the wax denture pattern is placed into position. If this relief is not provided, insertion of the lower denture will be difficult and painful.

## SURGICAL PROCEDURE FOR THE INSERTION OF THE DENTURE

If many teeth are to be removed under a local anesthetic, the extractions should be planned for two or more visits. The posterior teeth are removed first, and this portion of the mouth is prepared with the aid of the surgical template (Fig. 7).

Fig. 6.

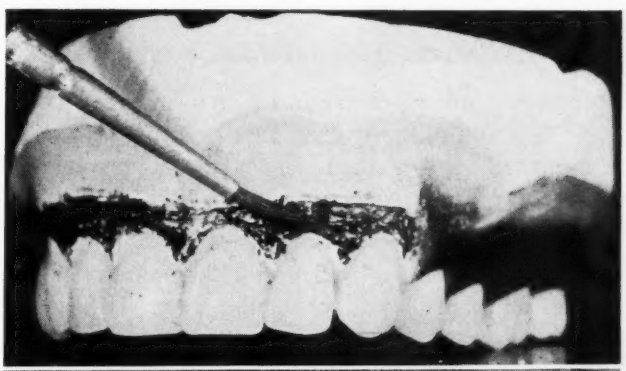

Fig. 7.

**Fig. 6.—The bare labial surface of the stone cast is coated with a thin layer of melted wax applied with a camel's hair brush. This wax surface is then stippled.**

**Fig. 7.—This surgical template was made to cover the posterior ridges as a guide for shaping the ridges so the denture can be inserted. The anterior teeth are removed at the next visit.**

The use of the template will prevent the need for additional surgical treatment of these tissues at the time of the insertion of the denture. The anterior teeth can be removed one week later and the denture inserted immediately.

When teeth are to be removed and the ridges trimmed under a local anesthetic, the injection should not be infiltrated under the periosteum in the anterior region. The periosteum should not be reflected higher than the planned line of the alveolectomy. This is 5 mm. above the gingival line in the anterior region and 1.5 mm. in the posterior region (Fig. 12). If the periosteum is reflected too high, the denture border will rest against scar tissue (Fig. 13). However, if specific sections of a tuberosity or of a torus mandibularis are to be removed, additional periosteum must be reflected.

When the remaining anterior teeth are removed, an alveolectomy which conserves as much bone structure as possible is performed. However, enough space must be made for the insertion of the denture which has been designed to reduce the distortion of the patient's facial contours and expression to a minimum. If all of the teeth are removed at one sitting, a transparent surgical template covering the entire basal seat of the denture is used.

## THE RELINE AND DUPLICATE DENTURE

Additional procedures are necessary in order to maintain the comfortable use of the denture and the health of the underlying tissues. The denture is relined six weeks after its insertion. It has been shown that the stroma of the bone is established by then.[4]

The use of the autopolymer acrylic resin materials for relining is a convenience. Good results are obtained by cleansing the impression surface thoroughly with soap and water, followed by pumice on the lathe. The cleansed and slightly roughened surface is again washed with soap and water and dried with an air blast. The surface to be relined is wetted with the monomer of the reline material to a line approximately 1/16 inch beyond the denture borders. This provides a good attachment for the new resin and creates a fine finish line. A more complete reline procedure is necessary after the ridges have resorbed.

For additional convenience to the patient, a duplicate denture can be made from the original cast at the time the original denture is fabricated. This second denture is carefully relined after the ridge tissues have resorbed.

## MAINTAINING THE SIX FUNCTIONS

This immediate denture technique duplicates in the denture base the dental and oral tissues to be replaced or covered. Therefore, the tissues and organs involved in mastication, deglutition, and phonation that lie against these surfaces are better able to fulfill their required functions.

The facial contours and expression of the individual are not changed because muscles and tissues supporting the face are maintained and preserved in their original position.

Fig. 8.

Fig. 9.

Fig. 10.

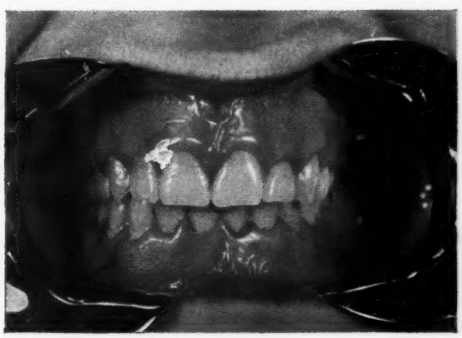

Fig. 11.

Figs. 8, 9, 10.—The completed denture. The polished surface duplicates the anatomic contours of the structures to be replaced or covered. The stippling and color characterizing duplicates the esthetic values of the mucous membrane while the teeth duplicate the dentition of the patient.

Fig. 11.—Upper and lower immediate dentures. The color and anatomic contours of the natural tissues have been duplicated in the denture bases.

When made in this manner, the immediate denture protects, splints, and stimulates the tissues it covers so that the health of the ridge is maintained.

Fig. 12.

Fig. 13.

Fig. 12.—The mucous membrane and periosteum reflected to the height of the alveolectomy. Small rongeurs are applied edgewise to prevent unnecessary removal of bone.

Fig. 13.—The mucous membrane and periosteum is reflected to a greater extent than is necessary. This will cause the formation of undesirable scar tissue at the borders of the basal seat area of the denture.

Finally, by duplicating the anatomic contour of the tissues it replaces, as well as the color and texture of the mucous membrane, the finished denture meets the esthetic requirements of these tissues (see Fig. 11).

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# TECHNIQUE FOR PACKING AND STAINING COMPLETE OR PARTIAL DENTURE BASES

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COMPLETE DENTURES and partial dentures with labial flanges are greatly improved esthetically by reproducing the natural contours of the gingivae surrounding the teeth in their flanges, and by tinting the acrylic resin bases to simulate the color of living tissues. When the acrylic resins first appeared, they were such an esthetic improvement over vulcanite bases that most dentists felt that the final goal had been reached. However, Pound[1] pointed out the fact that the "shiny pink" of the acrylic resins did not reproduce the color and contour of the natural gingivae. He and others have suggested techniques for overcoming this difficulty.

The procedure to be described for tinting the denture base is a modification of the one suggested by Pound; to the best of my knowledge, it was Hardy[2] who originated it. The technique allows the operator to observe his results while he is staining the resin, and it avoids the danger of crazing acrylic resin teeth by the monomer as the stains are applied. Also, it prevents the difficulty of having the stone core adhere to the acrylic resin teeth at the gingival crevice if the monomer contacts the teeth.

## THE TECHNIQUE

The denture is waxed-up and contoured to reproduce the buccal and labial anatomy as accurately as possible. This may be done free hand, by use of commercial patterns, or by the use of custom-made acrylic resin patterns, as suggested by Dirksen.[3] The labial flange must not be waxed too thick as it cannot be thinned down after the denture is processed. (The stained resin would be scraped or polished away.) The wax pattern of the flange must have a stippled effect over the buccal and labial surfaces, except in the region of the gingival margins which are normally smooth in natural tissues. Stippling may be accomplished by tapping the wax with a brush with stiff, short bristles, or by crumpling tin foil into a ball and pressing it against the softened surface of the wax. The wax should be flamed gently after stippling to round off the sharp points.

The first half of the flasking procedure is carried out in the usual manner. Separating medium is applied, and a core of stone is painted over the labial and buccal portions of the wax pattern and the teeth to a depth of one-eighth inch.

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This stone will record every detail in the pattern, including the stippling, which might be missed if the stone were simply poured over the waxed-up denture. A separating medium is applied to the core, and the investing is completed in the usual manner.

The wax in the flask is boiled out and, while the flask is still hot, the cast and the stone core are painted with a tin-foil substitute. The flasks are placed on edge to prevent the liquid tin-foil substitute from accumulating around the cervical ends of the teeth. After the flask has cooled to room temperature, a quarter-inch groove is cut around the labial portion of the land, about 3 mm. from the pattern of the flange (Fig. 1). This moat is to allow any excess acrylic resin to press into it,

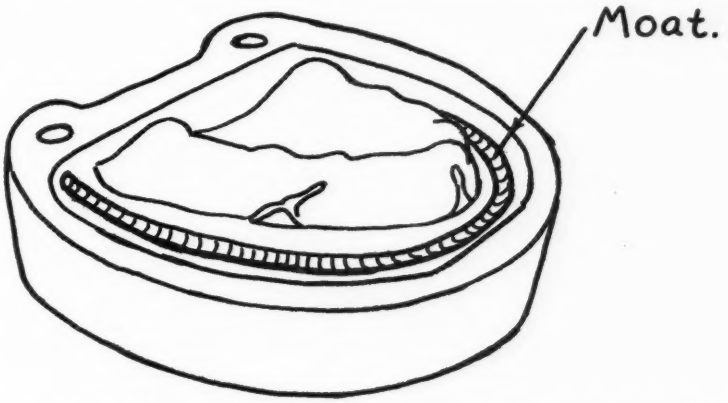


Fig. 1.—The cast is in the bottom half of the flask. Note the moat in the land for the excess acrylic resin.

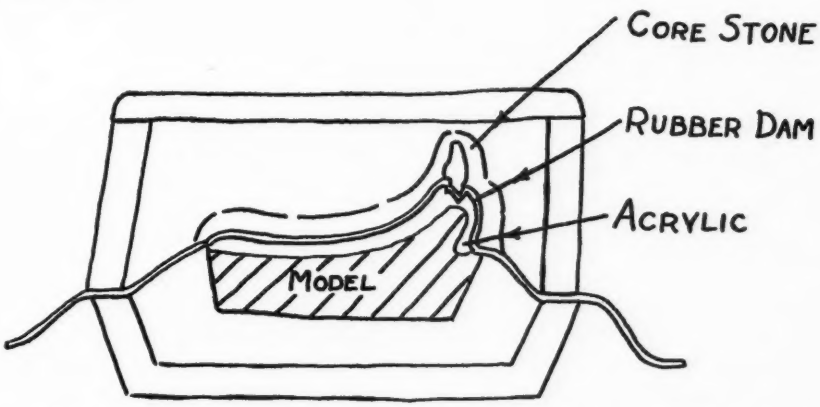


Fig. 2.—The flask closed for a trial pack. Note that the rubber dam is between the top half of the mold (covering the teeth) and the acrylic resin. Cellophane is used between the cast and the resin.

rather than to prevent complete closure of the flask. A sheet of rubber dam is laid over the *top* half of the flask covering the teeth and all of the investing stone. The acrylic resin is placed in the top half of the flask so that the rubber dam is between the teeth and resin. A sheet of cellophane is placed between the acrylic resin and the cast, and the first trial closure is made (Fig. 2). When the flask is

opened the rubber dam and the resin should stay in the top half of the flask. If the resin lifts out of the tooth side of the flask, it is replaced with the rubber dam between the resin and the teeth. The cellophane is removed, and any excess resin is trimmed away. The trial packing is repeated in the same manner until the mold is properly filled with the resin. The cast is painted again with the tin-foil substitute. The flask is pressed again, but on this closure the cellophane over the cast is omitted. This closure is the same as the usual final closure except that the rubber dam is retained in position between the resin and the teeth in the top half of the flask. The flask is opened carefully and usually the resin will remain attached to the cast in the bottom half of the flask. If it does not, the resin and the rubber dam are removed from the top half of the flask and placed in position on the cast. Then the rubber dam is removed.

## THE STAINING

With the acrylic resin in place on the cast in the bottom half of the flask, the portion of the resin to be stained is visible. The teeth remain in the top half of the flask because they were separated from the resin during the trial packing by the sheet of rubber dam (Fig. 3).

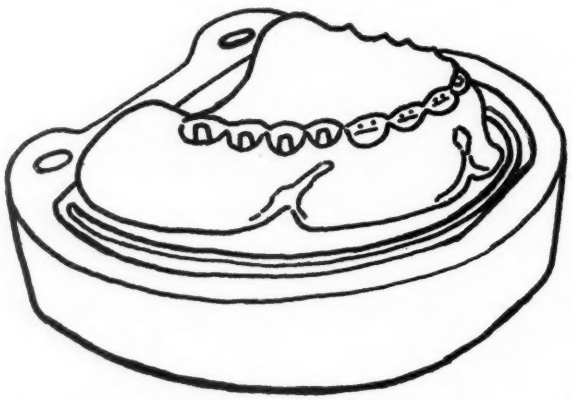

**Fig. 3.—The resin has been trial packed and is ready for staining.**

The objective of staining is to simulate the colors we see in the living tissues as closely as possible. The materials to be used have a different degree of translucency, texture, and body than living tissue. We are in much the same position as the portrait artist who is reproducing skin tones by means of oil paints. He does not use one color of pink for the entire face, nor do the colors he places on the canvas resemble tissue at all if we inspect the canvas closely. It is only when we step back a short distance from the painting that we see the excellent results of his artistry.

The stains* used are the colors suggested by Pound except that yellow is substituted for white, as recommended by Hardy. The stains are dusted into the

*The tinting materials used are manufactured by the Kay See Dental Manufacturing Company, Kansas City, Mo.

desired positions from their special containers. After the powder is placed (opposite four teeth at a time), it is wetted with monomer from an eye dropper with a 19 gauge needle attached.

The light yellow (No. 212) stain is placed first (Fig. 4). It may be used full strength or toned down by adding one-third of the white (H) stain to it. It is placed at the gingival margins at the position of each tooth, and particularly strong over the cuspid eminences. None is allowed to go onto interproximal gingivae. The powder is placed in regular sequence opposite four teeth at a time starting in the molar region. Each segment is wetted with monomer before the powder is applied to the next segment. The procedure is continued until all of the yellow is in place. The stain should be approximately 0.5 mm. in thickness. This small addition will not cause the mold to be overpacked.

Fig. 4.—The locations where the yellow stain is used.

Fig. 5.—The locations where the lavender stain is used.

A small quantity of lavender stain E mixed half and half with stain H is placed at the gingival margin in the same manner as above (Fig. 5). The amount of lavender stain to be used depends upon the patient's coloring. The Mediterranean peoples have more of this coloring in their gums and will need to have this stain applied over a greater area than others.

The pink stain A is placed in the same manner and in the locations indicated in Fig. 6.

The deep red stain (No. 4) is used on and near the borders, and at the positions of the buccal frenula (Fig. 7). This stain is quite strong and care must be used in adding it. A thin film of the stain is sufficient to deepen the color of the pink base.

Red nylon fibers (included in the staining kit) are mixed with clear acrylic resin powder and placed in a salt shaker. The entire labial surface is covered with this mixture, and wetted with monomer. The shaker will distribute the fibers evenly.

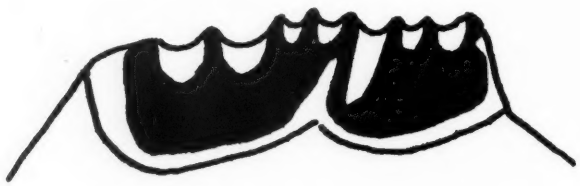

Fig. 6.—The locations where the pink stain is used.

Fig. 7.—The locations where the deep red stain is used.

## PROCESSING

The acrylic resin that goes into the retention holes of the teeth is wet with monomer. The stone in the top half of the flask is painted with a second coat of a tin-foil substitute. The flask is closed carefully in such a way that the stained portion of the resin does not scrape on the stone of the top half of the mold.

The resin is cured in the usual manner, separated, and a minimum of polishing is done. A prophylactic brush and flour of pumice are used on the labial surface. This is followed by powdered chalk on a soft brush wheel on the lathe. A sharp instrument is used to trim away any excess around the necks of the teeth.

The amount of stain and its distribution become a matter of each individual's judgment. Close observation of a patient's gingival tissues and observation of the stained denture in the mouth are the only ways to learn. A stained denture observed in the hand will seem to have extreme coloring, but in the mouth the coloring will blend with that of the mucous membrane, and all artificiality will disappear.

SUMMARY

A technique for tinting a denture base has been described in which the acrylic resin is separated from the teeth during the packing and staining procedure. The stains are applied to the uncured resin after trial packing and before processing. The final result is effective, and will not craze the denture base or brush away.

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# HOW DENTOGENIC RESTORATIONS INTERPRET THE SEX FACTOR

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SEX IDENTITY IN DENTURES is a symbol of progress in prosthetic dentistry, an artistic challenge to all of us, which is met with the application of "dentogenics." There is an individual latitude of esthetic freedom which we hope to share. Statistics of mechanical proportion have been put aside more and more as we have studied the cause and effect of the "denture look."

Shortly after the turn of the century, dentistry joined ranks in the mechanical march by adopting the theory of the square, tapering, and ovoid tooth form and face form as a *basis* for denture esthetics. Countless measurements, graphs, charts, and statistics firmly compressed all of humanity into this mechanical mold. The temperamental theory was replaced by the mechanical theory which did not recognize masculinity and femininity, and these important considerations were forgotten. Williams'[1] classification, although one of the greatest works in dental literature and of extensive anthropologic value, is too limiting for sex interpretation in dentogenics. Lulled by the pride of this fine classification, dentistry moved rapidly ahead in all other fields. As a result, the pleas for artistry in denture construction by such men as Bonwill, as early as the 1880's, seemed to fade in importance in the face of this early two-dimensional, geometric classification of Williams.

Mass production seized upon the thousands of calculations and brought to us artificial teeth of uniform size, shape, and color—all possessing a monotony of sameness. Technicians set these mechanically perfect teeth into precise, straight incisal lines and radially perfect long axes. Beyond the occasionally lapped lateral, deviations constituted an error—and so these setups, devoid of sex identity, became the "denture look." These appliances became recognizable as "false teeth," and dreaded by all patients because of the neuter-gender appearance they bestowed to the smile.

In retrospect we see that both esthetic and functional operations received treatment based on a mechanical impetus which has remained essentially unchanged in esthetics.

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This is second of a series of six articles. The first article, "Introduction to Dentogenic Restorations," appeared in the J. PROS. DEN. 5:586-595 (Sept.), 1955.

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The purpose of this article is an attempt to demonstrate how the sex factor can be incorporated into dental esthetics and thus permit an individual evaluation of the edentulous patient beyond the limitations of mechanical statistics. The original concept of these important considerations belong to Wilhelm Zech, a sculptor in Switzerland. He had observed that, though the efforts of the dentist in artificial dentures represented a form of sculpturing, they were devoid of the artistic principles and interpretations of the sculptor. He saw them as mechanical interpretations and reasoned that it was possible for the sculptor to express vigor and delicacy, vigor representing essentially masculinity, and delicacy, femininity, in his works of art. It should also be possible then for the dentist to do so in his artificial denture. So he applied sculpturing to teeth and achieved the effect of sex identity. This was an integral part of the thinking that led to the whole concept of "dentogenic restorations." Just as the sculptor, with his hammer and chisel, can create the beautiful feminine image of a Venus de Milo or the masculine form of a Thinker, thus can the skilled dentist and technician together create the same flow of masculine or feminine lines in the denture.

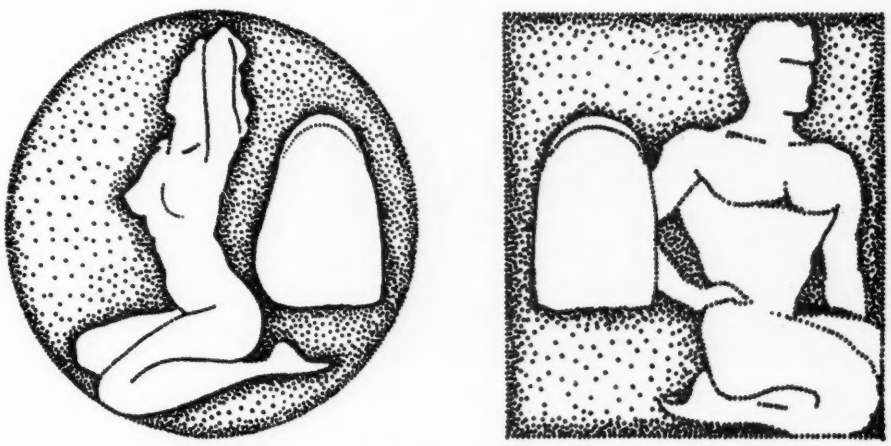

**Fig. 1.—The feminine form is spherical; the masculine is cuboidal.**

## THE DENTIST AS AN ARTIST

It is fundamental in our thinking that the dentist can be both an artist and sculptor. Some dentists may feel that they do not possess the imagination and artistic ability essential to put Sex, Personality, and a feeling for Age into a restoration.

We have found that this feeling for artistry and imaginative sculpturing can be grasped readily by the dentist once he has mastered the philosophy of dentogenics. It is a goal toward which the dentist can work all of his life. We do not expect that every dentist will find the same answer for every problem. Just as different artists would render different interpretations of a subject, so will dentists arrive at their own interpretations of an esthetic restoration problem. Each may be per-

fect in its own way, but just as artists' renderings will vary, so will the interpretations made by dentists vary. The goal is imaginative perception.

Imagine that you are walking along the street. A block away a woman walks toward you. You perceive at that distance that she is a woman. As she walks toward you, you gain an impression of her personality. As she passes you, you immediately classify her age. Then you draw other conclusions also; she is extremely feminine, or she is healthy and athletic; perhaps she is slightly overweight. These are the conclusions that the dentist must derive before he begins construction of a denture.

The authors, by pointing out the natural esthetic evolution inherent in a dentogenic restoration, hope to illuminate a new pathway and a new procedure to bring more mental comfort and well-being to denture-wearers, and a satisfaction to the dentist. Keeping a woman a woman and a man a man, after each loses the natural teeth, has become so important a problem that modern-day thinking emphasizes that a dentist must be an artist and a sculptor with highly developed perceptive qualities. He is rewarded by one of the most gratifying experiences a dentist may have.

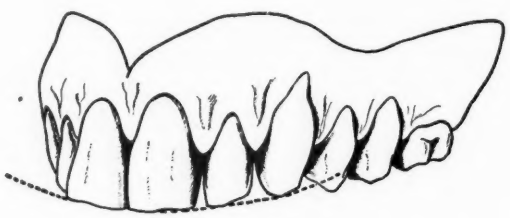

Fig. 2.—A curve suggests softness. Grinding of the incisal line to create this curve expresses femininity.

## THE EXPRESSION OF FEMININE CHARACTERISTICS

How is femininity expressed in the female form? A glance at the schematic feminine form (Fig. 1) is sufficient to illustrate the roundness, smoothness, and softness that is typical of women. In comparison to the masculine form, the *feeling* of softness is typical of femininity. It is not only a part of the body, but also of the spirit, typifying compassion and tenderness, sweetness and mother love. The feminine hand, in most cases, expresses these qualities, and it is apparent that to keep these ideas in mind in shaping the tooth is most appropriate. How does a dentist inject femininity into a denture? An excellent beginning is to select initially a mold which expresses softer anatomic characteristics, or one which is highly adaptable to being shaped and formed into a delicate type of tooth by certain recommended grinding procedures. The sculptor, in his interpretation of femininity, will keep to the spherical form (Fig. 1). We speak of *spherical* instead of *circular* so as to identify the third dimension which is so necessary to dentogenics and which has been minimized in customary esthetic procedures. The sculptor, by using the spherical form, imparts a sense of softness

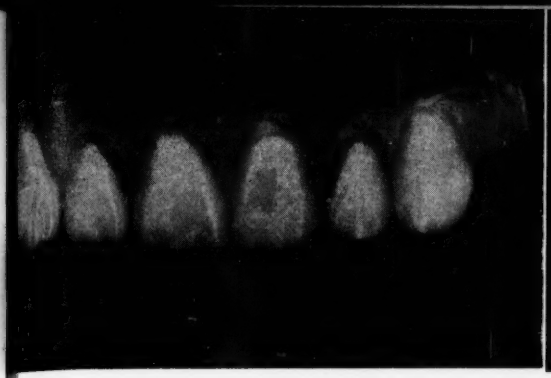

Fig. 3.—The degree of femininity must be carefully appraised. This is a softer type of interpretation in tooth form.

Fig. 4.—There can be vigor in femininity, and this is a more vigorous feminine interpretation of tooth form.

Fig. 5.—The sex, personality, and age of the patient should be carefully evaluated to provide definite dentogenic needs in denture construction. The depth of evaluation requires a study of the patient well beyond face form alone.

Fig. 6.—This denture, constructed according to dentogenic concepts, reflects the sex, personality, and age of the patient.

Fig. 7.—Tooth form helps in determining the degree of masculinity.

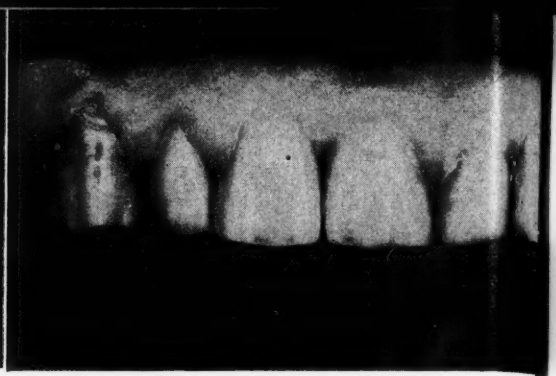

Fig. 8.—Vigor and strong masculinity can be projected by a "brawny" harshness in surface design.

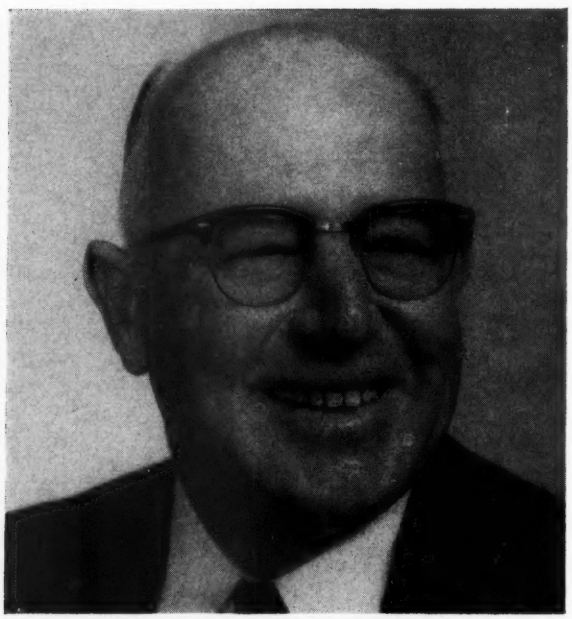

Fig. 9.—Interpretation of the entire physique is a basic requirement before selecting the mold and proceeding with the refinements necessary to meet the individual dentogenic needs of the patient.

Fig. 10.—A natural "smiling line" is achieved through careful positioning of the six anterior teeth.

to his subject which otherwise would be lacking (Fig. 2). We can do the same by infusing that feeling of soft femininity into the tooth and into the smile.

Therefore, the selection of a basic shape which has the soft lines expressive of the feminine form, together with effective personality characteristics, is particularly helpful. Thus, it is apparent that selection of a basic "feminine" tooth form is conditioned by the Personality and Age factors.* As an example, the "feminine" molds shown in Figs. 3 and 4 vary; the mold on the left is more soft and younger than the mold on the right.

Regardless of how "feminine" a tooth may be, it should be further developed according to the dentist's own interpretation of the degree of femininity which is suitable. Even though the dentist begins with a basically "feminine" mold, he should further harmonize it to the individual patient. Now, all femininity does not have the bloom of the healthy girl of 16 or the beautifully mature young wife of 28. However, there is still femininity in a woman of 60, 70, or 80, and that is where the artist's and sculptor's role is played. For, in the aging, the degree of femininity must be fairly and definitely appraised. A woman of 50 can be a very soft type or she may be quite a vigorous, sturdy type whose restoration must conform to a much more forceful interpretation (Fig. 4) than the soft feminine type (Fig. 3) which is so easily classified. Our individual interpretation of femininity in dentogenics is accomplished by definite grinding procedures. The grinding of the incisal edges must follow a curve rather than a straight line (Fig. 3). Here again, we return to the sculptor's illusions where a curve suggests softness, and thus femininity.

## THE EXPRESSION OF MASCULINE CHARACTERISTICS

How is masculinity expressed in the artificial denture? This can be answered essentially by asking ourselves how masculinity is expressed in the masculine form. A schema of the masculine form (Fig. 1) illustrates the cuboidal, hard, muscular, vigorous appearance which is typical of men. However, masculinity itself goes beyond the evaluation of the physical appearance. Masculinity expresses aggressiveness, boldness, hardness, strength, action, and forcefulness. This is illustrated by the classic appearance of the male clenched fist. Just as artists and sculptors are aware of these qualities, so the dentist-artist and dentist-sculptor should be.

A basic tooth form which expresses masculine characteristics shows vigor, boldness, and hardness (Fig. 8). The artists and the sculptors, in their basic interpretation of masculinity, impart a sense of harshness and angularity which is typical of the masculine form. Thus, as sex identity becomes an automatic part of our esthetic procedure, the tooth form will transfer automatically a sense of masculinity to the patient's smile.

Just as a basic "feminine" tooth form may be further individualized according to the dentist's own interpretation of the degree of femininity, so may the

*The subjects of Personality and Age as considered in dentogenics will be dealt with in subsequent articles.

masculine tooth form be further treated. It is true that some men have a qualifying softness which will guide us to compromise the typical hardness of a masculine tooth interpretation. This is apparent in the illustrations of the "masculine" molds which show how personality and age factors condition our selection of a mold for a man. As an example, the mold in Fig. 7 is less vigorous and younger than that in Fig. 8. This compromise begins with the selection of a basically "masculine" tooth form which is less harsh in its surface design and in its complete form. Fig. 7 shows a tooth form whose surface design is less harsh than the accompanying mold on the right (Fig. 8). By sufficient depth grinding (Fig. 13) and by further squaring the incisal edges of both the central and the lateral incisors, the effective employment of this basic tooth form can be seen in the man's smile (Fig. 10).

With another glance at the schema of the masculine figure (Fig. 1) and the masculine tooth form, we become aware immediately of the typical differences which can occur between the masculine and the feminine of both the human form and the tooth form. How does a dentist inject masculinity into a denture? The preceding evaluation is a constant consideration in effecting masculinity in the three basic parts of a denture which are the tooth, its position, and its matrix.

## SEX INTERPRETATIONS BY TOOTH POSITIONING

Positioning of the teeth is necessary in further conveying sex characteristics to a denture. However, definite positions cannot be assigned to one sex or the other because other factors than sex must be taken into consideration. To enable us to simplify and clarify this point we will consider some of the various positions of the six maxillary anterior teeth.

As a general introductory rule, the positioning of the anterior teeth has to depart from that compact wall of porcelain which is the usual characteristic of the "denture look." The mechanistic positioning of all of the six anterior teeth on a regular curve with similar long axes and identical incisal length is contrary to what we see in pleasing natural dentitions. We have now to introduce "lively" positions (Figs. 6 and 10) which are harmonious because they are inspired by the most pleasing natural tooth arrangement, but this is not to be confused with unpurposeful, "irregular" teeth.

*The Central Incisor.*—The two positions of the central incisors, set in perfect symmetry, are the starting positions for conventional tooth setups. By bringing the incisal edge of one central incisor anteriorly, we create a position which is evident but harsh. However, if we move one of the central incisors from the starting position out at the cervical end, leaving the incisal edges together, we have created a harmonious, lively position. This is the least noticeable of the three positions which are to be described.

The second and more vigorous position is to move one central incisor bodily anterior to the other.

The third position is a combined rotation of the two central incisors with the distal surface forward, with one incisor depressed at the cervical end and the other depressed incisally.

Of course, these three positions can be treated either very softly or more vigorously. Obviously, the softer positioning would be more favorable for women and the vigorous more favorable for men.

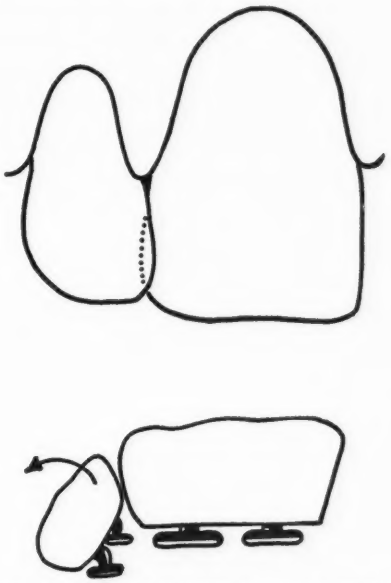

Fig. 11.—This positioning of the lateral incisors imparts a quality of feminine softness.

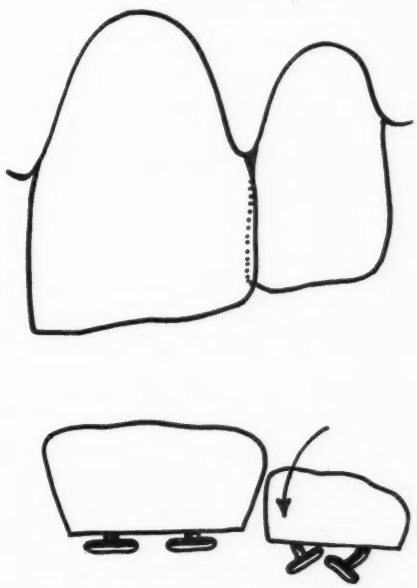

Fig. 12.—A hardened smile for the vigorous male can be achieved by rotating the lateral incisors mesially.

*The Lateral Incisors.*—The lateral incisors, being generally narrower and shorter than the central incisors, are less apparent; however, they can impart a quality of softness or hardness to the arrangement by their positions.

The lateral incisor rotated to show its mesial surface (Fig. 11), whether slightly overlapping the central incisor or not, gives softness or youthful coquettishness to the smile.

By doing the reverse, that is, by rotating the lateral incisors mesially, the effect of the smile is hardened (Fig. 12). We would select the soft positions for the very feminine smile, and the hard positions (even emphasized) for the vigorous male. It is important to note here that Nature never repeats herself, and, in the mouth, we avoid symmetry of tooth positions on both sides of the mouth.

*The Cuspid Teeth.*—The cuspids should never be set with the tip of the tooth out labially further than the cervical end, except in very rare instances where we have to harmonize the arrangement with a rough or primitive type of patient. In general, we will adopt for the cuspid conjointly the three following positions: (1) out at the cervical end, as seen from the front; (2) rotated to show the mesial face; (3) almost vertical as seen from the side (Fig. 13).

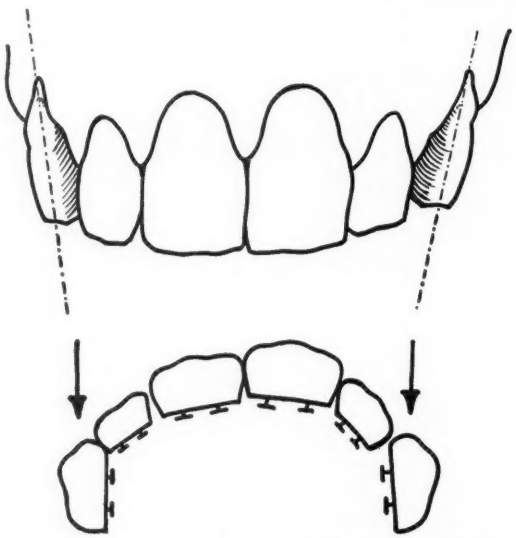

Fig. 13.—The position of the cuspid is of extreme importance. This schema shows the basic position of the cuspid in dentogenic restorations.

It is evident that a prominent cuspid eminence gives to the cuspids greater importance and therefore gives to the smile a vigorous appearance more suitable to the masculine sex. It becomes apparent that if all the tooth positions can be used for both sexes, the degrees of hardness or softness are variable and will depend on the characteristics of hardness or softness expressed by the individual patient.

## THE THIRD DIMENSION—DEPTH GRINDING

The "denture look" is due mostly to the flat appearance of the artificial upper anterior teeth, their lack of depth, or of "body." Due to mechanical obstacles, the tooth manufacturers seem unable to create molds which show a spherical or

cuboidal mass which is so important to the illusion of life in the denture appearance. Thus, the regular row of similar-looking teeth, the wall of porcelain already described, and the flat appearance of artificial teeth add a "bridge-facing look" to the denture.

We always need that feeling of depth, that third dimension, for realism. We need adequate porcelain to portray health and vigor and to harmonize with plain, rounded or athletic features and body contours. The third dimension is used as well for women (spheroid shape) as for men (cuboid shape). The depth grinding is done moderately for both men and women of average proportions, and it should be increased as an individual interpretation of the sex, personality, and age of the patient—for ample-bodied women and vigorous men—and on to a point of "bony" appearance exclusively for the most vigorous types of masculinity. Without this factor of perspective or third dimension, the most perfect restoration will lack the touch of authenticity, of life.

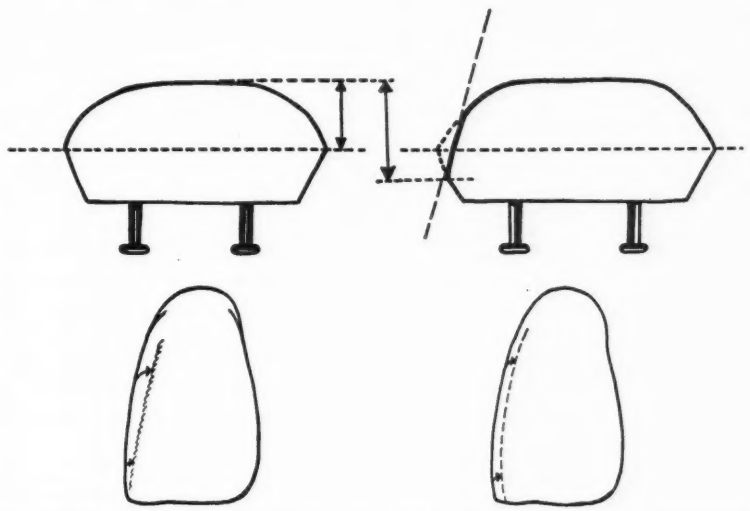

Fig. 14.—"Depth grinding" accentuates the third dimensional depth necessary for true dentogenic restorations. On the left is a typical defect of artificial teeth. On the right is the correction.

The depth grinding is done on the mesial surface of the central incisor only. Central incisors are the widest, almost always the longest, and therefore the most noticeable of the six anterior teeth. They must be harmonized with the whole physical personality of the patient: to vigorous patients belong vigorous central incisors; to delicate patients belong delicate central incisors. Neglect of this important point leads the observer to sense that something is wrong, and a doubt is incurred as to the denture. The illusion is simply not there.

We can use manufactured teeth with their technically imposed deficiencies to fool the eye of the observer by creating the third dimension by a depth-grinding procedure as follows (Fig. 14): With a soft stone, the mesial-labial line angle of the central incisor is ground in a definite and flat cut, following the same curve as the mesial contour of the tooth in order to move the deepest visible point of

the tooth further lingually. After this cut has been made, a careful rounding and smoothing of the sharp angle made by the stone must be accomplished, and a perfect polish must be given to the ground surface so that it cannot be distinguished from a surface produced by a glaze in a porcelain furnace.

It is necessary to develop the desired effect in depth grinding by a consideration of these main factors: a flat, thin, narrow tooth is delicate looking and fits delicate women (little depth grinding); a thick, "bony," big-sized tooth, heavily carved on its labial face, is vigorous and to be used exclusively for men (rather severe depth grinding); for the average patient, a healthy woman, or a less vigorous man, the depth grinding will be an average between delicate and vigorous, the feminine or masculine characteristics being given by other tooth shaping, the incisor grinding, and the positioning of the teeth.

Depth grinding reduces the width of the central incisors according to the severity of grinding to be accomplished. Therefore, to maintain the normal harmony of contrast in size between the six anterior teeth, a larger size central incisor of the same mold should be selected. Naturally, the same contrast can be made by selecting a smaller lateral incisor and cuspid of the same mold.

## SEX INTERPRETATION RELATED TO EMOTIONAL DISTURBANCES

A denture with a neuter-gender appearance is of doubtful value to a woman of any age. It is particularly harmful in younger women when a personality-repressive neurosis occurs as a result of the "denture look." This appearance causes them to hide their mouths and usually contributes to a neuromuscular restraint of the myofacial area, and the avoidance of the head-up, eyes-on appearance. What a satisfaction it is when we create restorations which are completely natural and which allow a completely uninhibited smile. The achievement of sex identity is necessary to maintain personalities, to improve personalities, and to create even new pleasing personality traits in our patients.

## A FEMININE SEX INTERPRETATION

Mrs. B. (Fig. 5) was a placid woman whom we would characterize as a "soft" type of female. Her body outlines were rounded; her hands soft, round, and feminine. She was shy, middle-aged, slightly obese, but had a jolly disposition. We should always consider the entire sex, personality, and age of the patient as we approach an evaluation of definite dentogenic needs in denture construction. It can be seen readily that our depth of evaluation must transcend the limitation of face form if we are to evaluate these needs and transpose their fulfillment to a denture. For example, the entire three-dimensional physique (Fig. 5) is considered more important in the selection of the central incisor mold than a two-dimensional face form concept which eliminates any esthetic consideration of the part of the patient below the neck. Here is where we are able to extend our esthetics to include sex interpretation for this woman.

In choosing the tooth, the first consideration was the selection of a mold typically feminine and sculptured for a rounded body outline (Fig. 4). In refining

the basic "feminine" mold to correspond in appearance to an extremely soft, pleasing personality, depth grinding (Fig. 14) of the mesiolabial angle was done, and the incisal edges of the central and lateral incisors were rounded to produce a softer appearance, according to her feminine requirements. A moderate amount of abrasion grinding was done on the cuspid tip to conform to the sex of the patient as well as to her age. There was a distinct abrasion grinding done on the incisal edges of all the teeth, again, to conform with her age. The basic color texture of the mold selected consists of twelve different baked-in pigments along the incisal third of the tooth, which gave a pinkish-gray color reflection and a proper dentinoid opacity. In a younger person, a greater amount of blue texture would be observed in the natural teeth, and thus we would have altered the shade of the tooth selected for a younger woman.

The position of the central incisors was kept at a minimum of activity. One was placed only slightly in advance of the other. The position of the lateral incisors, although displaying the mesial surface of the right lateral incisor by rotation to suggest softness, shows the left lateral placed with a mesial diastema, femininely compatible, and in conformance with the age of the patient (Fig. 6). The diastema was employed because a woman of her age might logically have lost a tooth in the posterior part of the dental arch without having had it replaced.

Because of the age and general personality of this patient, the denture base was made with full interdental papillae. We generally consider deeper color combination of tissue tones in the denture base to be more masculine in feeling than a lighter combination which is more bland, smooth, and feminine in feeling. We would appeal to every dentist, in his professional experience and ability, to give the technician the necessary information whereby fulfillment of Sex, Personality, and Age factor interpretation can be accomplished in the laboratory phase of dentogenics.

### A MASCULINE SEX INTERPRETATION

Mr. R. (Fig. 9) was a typically vigorous, middle-aged man. Again, the entire physique is observed and interpreted in the selection of the central incisor mold. It should be remembered that we select a mold with a basic masculine personality or character, and then proceed with the refinements necessary to meet the other individual dentogenic needs. The mold selected (Fig. 7) for this man has been altered considerably by the time it reaches the mouth, but the basic masculine effect is not lost. In selecting the mold for him, we chose one with vigorous sculpturing and cuboidal in basic form. In choosing the central incisors we looked for those which could be depth-ground considerably along the mesiolabial angle in order to impart a "bony" effect which is hard and masculine appearing.

The central incisors were placed in bold, prominent positions and rotated on their long axes so as to bring the distal surfaces slightly forward. This accentuates the aggressive position of these "strength and action" teeth, and tends to subdue the importance of the lateral incisors (Fig. 12). We want to accentuate this effect in the vigorous, male personality. The lateral incisors, with their masculine surface anatomy, were squared and the mesial surfaces were rotated

inward. The cuspid, in its role of civilizing the smile, was hardened by a vertical position, and by rather severe abrasion grinding on the tip. The positions of the six anterior teeth in this man result in the creation of an upward sweep of the incisal edges of the central and lateral incisors. This is called the *smiling line* (Fig. 2). In the denture base, more rigorous surface anatomy is also employed for a man than for a woman.

## SUMMARY

The Sex factor, the first of three important factors in the concept of dentogenics, has been discussed. A feminine tooth in a masculine mouth is just as much out of place as a young tooth in an old mouth. The selection of the mold, the teeth, and the denture base, and, most important, the positioning and the coloring of the artificial teeth and denture base should be influenced by the sex, as well as the personality and age of the patient. The prosthodontist can develop into both an artist and a sculptor, with both the artist's and the sculptor's imagination. The dentist must recognize the sex and then discover the personality of his patient which can then be expressed dentogenically in the restoration made for that patient. The laboratory procedures must carry through the artistic concepts of the dentist. There is a degree of masculinity in many feminine patients. There is a degree of youthfulness in many elderly patients. To determine these factors and to balance them with the artistry of practical denture construction is the problem.

The interpretation of the vital sex factor can be of great moral and psychologic help to the patient. The second factor in dentogenics—Personality, will be described and its application demonstrated in a subsequent article.

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# DIAGNOSIS AND TREATMENT PLANNING

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OUR FIRST CONTACT with and first impressions upon the patient may be very lasting, so we must be sure all details of cleanliness, of person, and of office are above reproach. Our first project is to determine with what type of patient we are to work. Let us try to place the patient in a classification of mental attitude as quickly as possible, and remember that the patient is classifying us at the same time. Three possible classifications are: (1) House's classification which designates patients as having a philosophic, exacting, indifferent, or hysterical mental attitude. (2) One which designates patients as alimentary, thoracic introvert and thoracic extrovert, osseous, cranial, etc. (3) One which separates patients into two groups: (a) those I can satisfy and get paid by and (b) those I cannot.

The type of classification used is not so important, but we must make some definite classification. If a patient is not acceptable, we should reject him at once, because little good can come to either ourselves or the patient if we continue. When mental harmony cannot be established between the patient and the dentist, it is better not to start, as failure is inevitable.

The general health of the patient must be considered in making our plan. Aging patients must be evaluated as to muscle tone and adaptability. A careful appraisal of the diabetic patient must be made because of a possible hourly tissue change. Hypertension, heart disease, and cardiovascular disturbances are not of special importance as such, but they must be included in our diagnosis to give us an over-all health picture. Kidney dysfunctions must be carefully considered as a factor in base stability. Occupation and nervous habits can have a bearing on complete denture prosthesis.

## ORAL CONDITION

The oral condition is carefully observed. Full mouth roentgenograms are necessary. We have found that nearly 30 per cent of edentulous patients have retained root fragments, impacted teeth, residual areas of infection, or some other pathologic condition which needs attention before prosthetic treatment is begun. Needless to say, these conditions must be corrected, with rare exceptions. Any growth should be carefully scrutinized, and any suspicious portions should be

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sectioned and examined microscopically for evidence of malignancy. Any excess soft (hyperplastic) tissue covering the ridge should be removed surgically because little success can be expected when dentures are built on an unstable loose-tissue foundation.

Adequate interdental space is necessary, If it is insufficient, surgical interference should precede the making of impressions. Opposing undercuts may need surgical attention if they interfere with a proper seating of the finished denture. The surgery should be outlined carefully by the prosthodontist so that scar tissue which may result will not be in a vital spot, and will not interfere with the retention of the denture.

The color of the mucous membrane in the oral cavity should be scrutinized for indications of anemia or vitamin deficiency. A vitamin deficiency may be the cause of continued soreness under dentures. This deficiency can be aided by large daily dosages of vitamins which include thiamine, riboflavin, and niacin. This combination of vitamins will result in a feeling of well-being on the part of the patient and reduce the amount of soreness under the dentures. This will reduce the number of adjustment periods, and result in a better satisfied, more comfortable patient.

## DENTURE OUTLINE

Any complete denture should cover all the available basal seat area without interfering with muscle action. The upper denture should cover all of the area labial and buccal to the ridge and extend to the tissue turn or cul-de-sac, allowing a fan-shaped relief for the frenula or muscle attachments. The tuberosities should be covered completely by the denture, and it should extend posteriorly into the hamular notches. The distal end of the denture should extend to cover all of the surface in the palate to the vibrating line. The area from the distal portion of the palatine bone to the vibrating line is the postpalatal seal area. It seems likely that more accuracy and control can be obtained by scraping the cast at the postpalatal seal area than by other means. Scraping must accommodate for the shrinkage of the acrylic resin as well as aid in masticatory function.

The extension of the lower denture should include, anteriorly, all area to the tissue turn. The extension of the posterior buccal flange should be governed by the "flex" line of the buccinator muscle. The retromolar pad should be covered entirely except in unusual situations in which the pterygomandibular raphe comes too far forward, and thus tends to unseat the lower denture when the mouth is opened. In these instances, the posterior extension should be shortened to accommodate for this unusual muscle action.

Immediately below the retromolar pad, on the lingual side of the ridge, is an area which is posterior to the attachment of the mylohyoid muscle. The amount of space in this area can be determined by having the patient protrude the tongue gently and checking the amount of space which is available without interference from the structures of the floor of the mouth. That amount of area should be included in the denture coverage.

Progressing forward, the lingual flange is shortened so as not to interfere with action of the mylohyoid muscle and the structures of the floor of the mouth which

cover the muscle. The denture outline may drop down in the molar region, as the mylohyoid ridge and attachments do, being governed only by the action of the structures of the floor of the mouth. The denture outline rises in the lingual anterior region to clear the lingual frenum.

### VERTICAL DIMENSION

The determination of vertical dimension is important in complete denture prosthesis. Any method which works well in the dentist's hands is acceptable, as there is no known sure way of obtaining this measurement. Measuring from soft-tissue landmarks is of doubtful value, as it is difficult to keep the tissue from moving over the bony support, and thus destroying the accuracy of the measurements.

Centric relation is extremely important. No fault could be found with a normal method of recording it, if it is really recorded. The use of a Gothic arch tracing, however, is the safest in most dentists' hands. We should, by all means, use a good method of stabilization of baseplates for any registration.

The value of protrusive and lateral interocclusal records is a much-discussed problem. We know they are positional and not completely accurate. They are more accurate than using an average condylar inclination. The size of the average man's foot in the Army was 8½, but we would have many uncomfortable feet should we all use average-sized shoes. Do we think more of our feet than we do of our mouths?

Surely no examination is complete without checking the temporomandibular joint for possible disturbances. A clicking joint or an irregular closing pattern is oftentimes a forerunner of joint trouble. The temporomandibular joint is a part of the body, and any dysfunction in it can produce other body malfunctions leading to headaches, migraine, stomach disorders, and other disturbances. Too little attention is paid to this joint in denture work. We must realize the desirability of obtaining a true physiologic muscle-joint balance.

### SALIVA

We should attempt to eliminate saliva in all cases before impressions are started. This is particularly true when there is an excess of thick ropy saliva. Saliva as a problem may be eliminated by using the following procedure: Place about ¼ teaspoon of true Caroid powder on a glass slab. Mix it thoroughly with just sufficient glycerin to make a thin paste. Place this mixture in ½ glass of water and mix. Have the patient rinse the mouth once or twice before making the final impressions.

### FEES

A discussion of fees is a definite part of treatment planning. A tentative fee should be given to the patient before the work is started. A high and low figure should be given. For instance, the patient can be told that the dentures will cost between $225.00 and $300.00. Explain that the final figure will be given at the

try-in stage. The financial arrangements must be talked over and agreed upon before starting the work. At this time, no one is unwilling to talk finance, and no one is "insulted." If you quote the final fee at the try-in, try to have it slightly below the high figure. Psychologically this is a great help. The fee should never be raised above the "high" formerly given.

After all factors have been discussed and agreed upon, construction of the denture may be started. The work should be done slowly, carefully, and accurately. No step is more important than the one being done at the time. The patient should be told what you are going to do, and then you should do it. The steps should be explained to your patient as you work. Patients are most interested in their own mouths.

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# THE SIGNIFICANCE OF VERTICAL DIMENSION IN PROSTHETIC DENTISTRY*

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DURING THE PAST FEW YEARS, vertical dimension has come to be one of the most talked about topics in prosthetic dentistry. There are so many methods of determining vertical dimension that it is difficult for one to make definite statements with an assurance of being correct. Nevertheless, the establishment of a correct vertical dimension is perhaps one of the most important steps in the construction of artificial dentures. The purposes of this article are to review the anatomy and physiology of the chewing apparatus, and to discuss the sequelae of securing a faulty vertical dimension.

## ANATOMY OF THE TEMPOROMANDIBULAR ARTICULATION

Shapiro[1] classifies the temporomandibular articulation as a ginglymoarthrodial or gliding hinge type of joint. It consists of two opposing bony surfaces separated by an interarticular disc and enclosed by an articular capsule (Fig. 1).

1. The mandibular (glenoid) fossa of the temporal bone extends anteriorly to include the articular eminence at the root of the zygoma. It is composed of an anterior and a posterior half. The anterior portion is fuller and deeper and is the articulating portion of the fossa. Articular cartilage covers the surface of this fossa.

2. The condyle of the mandible consists of a rounded, elliptical, bony head with a neck which is usually tilted forward. The upper and anterior surface of the condyle in centric occlusion articulates with the posterior surface of the articular eminence. Articular cartilage covers the surface of this condyle.

3. The articular disc or meniscus is an oval structure which is a relatively thin plate of fibrocartilage. Its lower surface is concave and its upper surface is convex conforming to the shape of the structures it approximates.

4. The two synovial membranes or sacs are placed one above and one below the articular disc. The superior membrane, which is the larger and looser of the two, extends from the inferior of the mandibular fossa and articular eminence onto the superior surface of the disc. The inferior membrane passes from the inferior surface of the disc onto the neck of the condyle.

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**Senior student at the University of Iowa, College of Dentistry, at the time this essay was written (graduated in June, 1955.)

5. The articular capsule is a thin, loose, fibrous sac which encloses the joint cavity. It is attached superiorly and anteriorly to the margins of the articular tubercle, and medially, laterally, and posteriorly to the margins of the mandibular fossa. The lower portion of the capsule is attached to the neck of the condyle.

6. Four ligaments help to hold the condyle in place and also limit the range of movements of the mandible. They are the capsular, also known as the articular capsule, the temporomandibular, the sphenomandibular, and the stylomandibular ligaments.

## INNERVATION AND BLOOD SUPPLY OF THE JOINT CAVITY

The temporomandibular articulation is innervated by the auriculotemporal and the masseteric branches of the mandibular nerve. Terminal fibers of sensory and vasomotor nerves are found in the connective tissue of the synovial membranes. The cartilage of the joint, of course, has no nerve supply.

The vascular supply of this articulation comes from the superficial branches of the external carotid artery. Tiny branches pass into the ends of the bones, to the margins of the articular cartilages, and to the articular capsule. The surfaces of the cartilage have no blood supply as would naturally be expected. The synovial membranes, located above and below the articular disc, are supplied with a rich network of minute vessels at the synovial fringes.[1]

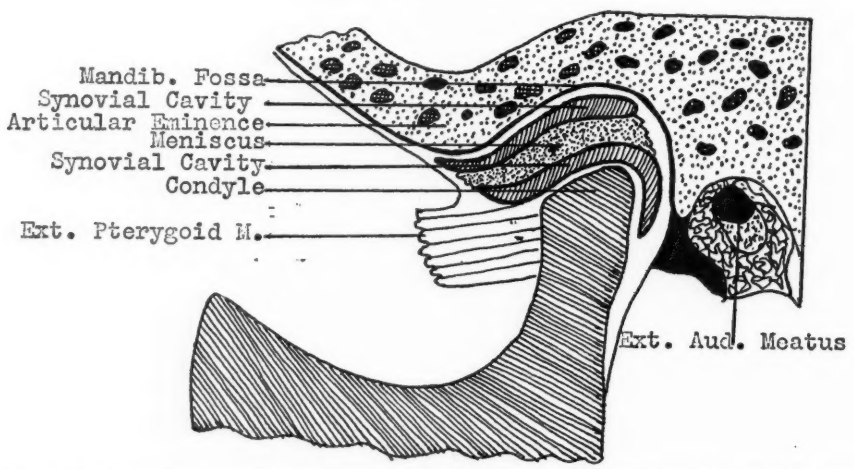


Fig. 1.—The temporomandibular articulation, showing the relationship of the synovial cavities and the articular disc to the condyle and mandibular fossa.

## MUSCLES THAT MOVE THE MANDIBLE

There is considerable controversy as to which muscles actually cause the mouth to open. The fact, however, that the jaw moves forward when it moves downward has been demonstrated and accepted for some time. The external pterygoid muscles function on both sides of the mandible, and pull the condyles and articular discs downward and forward in opening the jaws. The suprahyoid muscles, which include the anterior belly of the digastric, the mylohyoid, and the

geniohyoid, also assist in depressing the mandible, but only when the hyoid bone is fixed. Gravity, of course, aids to some extent, depending on the weight of the bone.

There are three muscles that are involved in the raising of the mandible: the temporalis, the masseter, and the internal pterygoid. Of these, the temporalis muscle is the most powerful.

It is perhaps obvious that the muscular activity such as occurs during ordinary conversation differs from that which takes place when a person is yelling. Also, the movements of the jaw during mastication of a small, soft piece of food are unlike those that occur when a person is chewing a hard piece of candy. Therefore, some of the muscles usually referred to as participants of the jaw movements do not function equally at all times.[1]

The physiologic rest position of the mandible is the position that the mandible assumes when the mandibular musculature relaxes to tonic contraction.[2] Investigators have found that, for each person, the physiologic rest position is constant throughout life.[3] It is generally accepted that the mandibular and maxillary teeth are separated by a distance of from 2 to 5 mm. at this rest position.[2] This space that exists between the rest position and occlusal contact position is known as the free-way space. The muscles function most efficiently at the rest position. Therefore, to attain optimum muscle function, it is extremely important that the correct rest vertical dimension is established.

## NORMAL MOVEMENTS OF THE MANDIBLE

It must be kept in mind that there are two distinct joints involved in this articulation—one between the condyle and the articular disc and another between the disc and the mandibular fossa. When the mouth is only partially opened, as in talking, the movement is confined to the lower of the two joints. However, when the mouth is opened wider, both joints are involved in the movement. In the lower joint, the movement is of a hingelike nature, the condyle moving around a transverse axis on the disc, while in the upper joint the movement is of a gliding character, the disc, together with the condyle, gliding forward onto the articular eminence, around an axis which passes through the mandibular foramina. In closing the mouth, the action is just the reverse of the action described for opening the mouth.[4]

When the mandible is moved into a protrusive position, the movement takes place principally in the upper joint, the disc and the condyle gliding forward on the mandibular fossa and articular eminence.

When the mandible is moved into a right lateral movement, the left condyle moves downward, forward, and slightly inward, while the right condyle rotates in the fossa. In left lateral movement the action is just the opposite.

The control of the condyle relations in the glenoid fossa is usually dependent upon muscle function moving the jaw to the tooth occlusion within limitations of the anatomic structures. If the occlusion is normal, at the proper vertical height, and in the centric position, the jaw position will be normal and the condyle will be in the proper relation to the other anatomic structures of the temporomandibular joint.[5]

## SEQUELAE OF INCREASING THE VERTICAL DIMENSION

A haphazard attempt in establishing the correct vertical dimension may produce good results at times. But all too often this is not the case, and the operator suffers serious consequences as a result of a very dissatisfied patient.

A danger in denture construction is the increasing of the vertical dimension which in turn reduces the free-way space. As a result of this, the teeth are brought into premature contact during mastication and swallowing. This repeatedly subjects the bony ridge and other supporting structures to extremely damaging forces. The ridges are traumatized, and resorption ensues until the minimal free-way space is re-established. This results in a loose fitting denture and a smaller ridge to work with in construction of another set of dentures.[6]

Also, a clicking of the teeth may result when speaking, which can become extremely aggravating. The face has a strained appearance, and the patient will experience difficulty opening the mouth sufficiently to take bites of food comfortably.[8] The patient will complain of fatigue and pain in the muscles controlling the mandible, since in such cases, the muscles involved are stretched and therefore under terrific strain.[7] For centric relation, the condyle can only assume a position anteriorly to that which it normally should be occupying beneath the anterior part of the glenoid fossa[8] (Fig. 2).

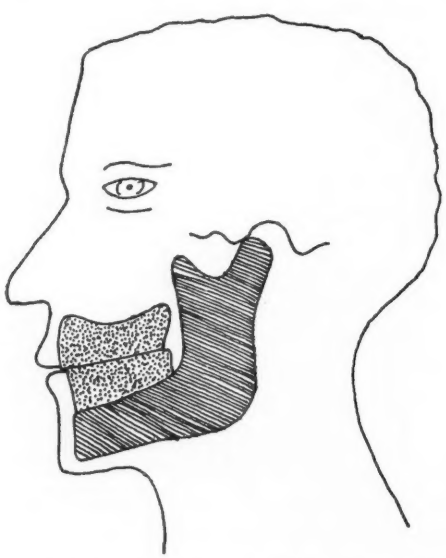

Fig. 2.—The vertical dimension increased, with resulting faulty relationship of the temporomandibular articulation.

## SEQUELAE OF DECREASING THE VERTICAL DIMENSION

Another danger in denture construction is the decreasing of the vertical dimension. Overclosure reduces biting force and consequently reduces soreness; therefore, it is often used to this end. However, this causes the chin to become too prominent. The lips lose their fullness and the vermillion border area is

reduced to approximately a line. The decreased dimension reduces the function of the muscles with a resultant loss of muscle tone, which gives the face an appearance of flabbiness instead of firmness. It also results in the loss of the cubicle space of the oral cavity. The tongue, at rest normally, completely fills the oral cavity; therefore, an overclosure will have a tendency to push the tongue toward the throat, with the result that adjacent tissues will be displaced and encroached upon. Encroachment may mean the closure or occlusion of the opening of the eustachian tubes, which would interfere with the function of the ear.[8]

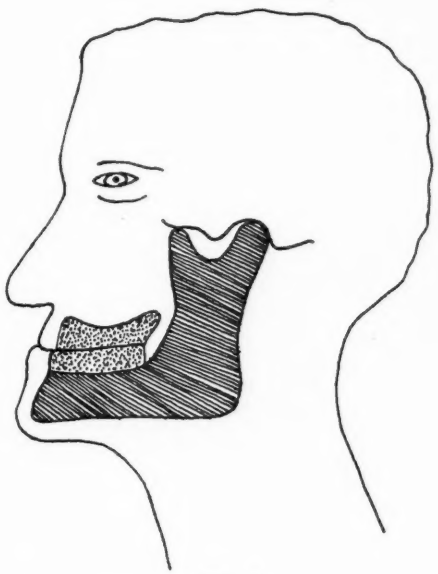

Fig. 3.

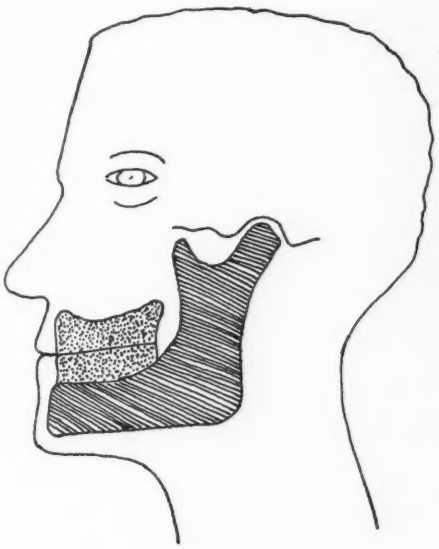

Fig. 4.

**Fig. 3.—The vertical dimension decreased, with resulting faulty relationship of the temporomandibular articulation.**

**Fig. 4.—The vertical dimension established correctly, with resulting normal relationship of the temporomandibular articulation.**

In bringing the teeth into occlusion, the condyle may be posterior to its normal position beneath the anterior part of the glenoid fossa. This may produce a functional pathologic disturbance in the temporomandibular joint which is spoken of as traumatic arthritis. Traumatic arthritis is a chronic inflammatory condition which is caused by minor injuries affecting the synovial membranes of the joint surfaces or the meniscus, or both. This joint becomes painful, and there may be swelling in the preauricular area and limited mandibular motion. In cases of long standing, there may be permanent defects. Clicking of the joint is a frequent symptom and is due to changes in the meniscus. Costen's syndrome is frequently associated with this type of arthritis. This syndrome consists of various forms of neuralgia, such as headaches about the vertex and occiput, pain behind the ear, in the mouth, and the tongue. A theory is that these are reflexes from the auriculotemporal nerve and the chorda tympani nerve[8,9] (Figs. 3 and 4).

## CONCLUSION

It is apparent that there are a number of factors that influence the action of the masticatory apparatus. The relation between the joint proper, the muscles involved, and the action of the temporomandibular articulation is a very complex subject. Also, it is apparent that if the vertical dimension is not established properly, a number of difficulties arise. The operator should always be conscious of all these facts and endeavor to establish as nearly correct a vertical dimension as possible. Prosthetic dentistry is certainly a health service, and to establish the correct vertical dimension is one of the best preventive measures available.

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# SOME PHYSIOLOGIC CONSIDERATIONS OF CENTRIC AND OTHER JAW RELATIONS

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A KNOWLEDGE OF MASTICATION would seem to be best based upon a study of the dynamics of the complete masticatory system. We dentists have a tendency to concentrate our attention upon the teeth and supporting osseous structures. However, the masticatory apparatus is controlled and powered by nerves and muscles. Neuromuscular reactions are less easy to describe, to measure, and to study than bone and tooth relationships, but obviously no less important. This article is a discussion of the neurophysiologic regulation of centric relation and other jaw positions.

## THE ORIGINS OF THE VARIOUS JAW POSITIONS

The first question which might well be asked is, "How and when do the different jaw relationships originate?" Let us begin with the easiest to understand.

Under most conditions of posture, there are muscles whose function is to maintain the body in position. This process is made possible by the stretch or myotatic reflex. The slightest relaxation of a muscle or part of a muscle increases its length. This minute amount of stretch stimulates proprioceptors found abundantly in all antigravity muscles and their tendons. The resulting nerve impulse from the stimulated proprioceptor reaches the spinal cord by means of a sensory fiber which synapses with a motor neuron. The axons of the motor neuron, in turn, transmit the impulse back to the muscle originally stretched, causing this muscle to contract just enough to regain its former length (Figs. 1 and 2). The continuity of gravity causes a constant shower of asynchronous reflex motor discharges to the muscles resulting in a mild state of contraction or tension at all times. This is the postural contraction. The position of the bone being maintained against gravity is spoken of as the postural position.

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The mandible is moved and supported by a group of muscles most of which receive their innervation from the fifth cranial nerve. They are classic examples of antigravity muscles. The postural reflex controlling the position of the mandible against gravity has its synaptic connections in the brain stem in a similar manner to those of the limb and back muscles in the spinal cord. The proprioceptors (muscle spindles) of the muscles of mastication are joined by afferent fibers which run through the mesencephalic root of the trigeminal nerve. The cells of origin of these sensory fibers lie in the mesencephalic nucleus. They are thus able to synapse with motoneurons of the trigeminal nerve, forming a simple stretch reflex

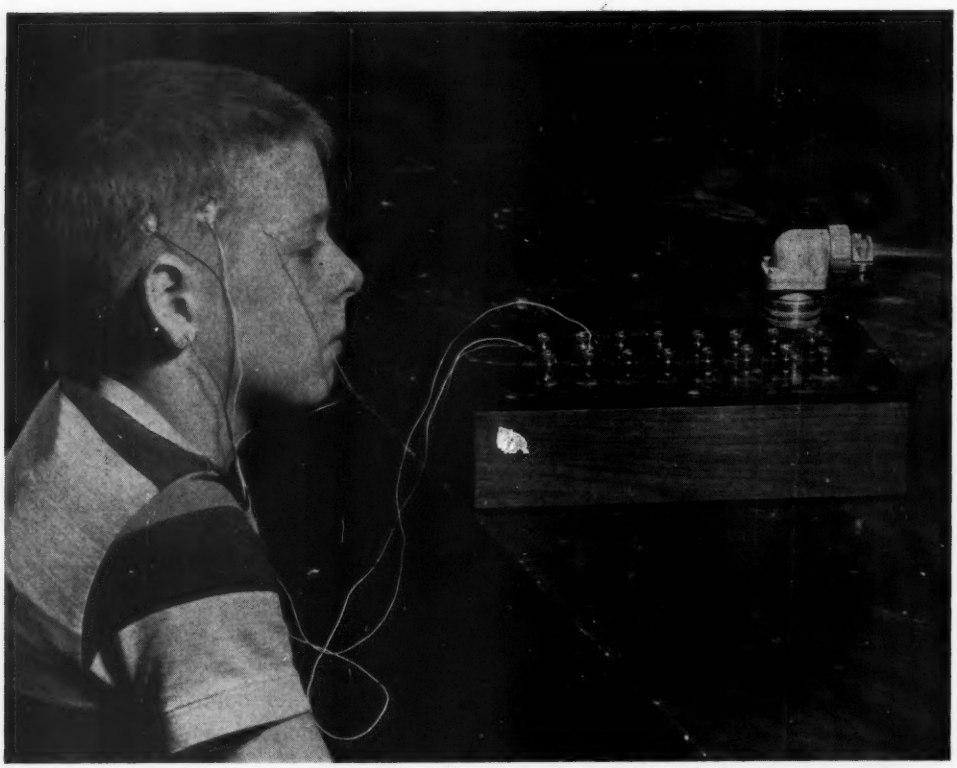

Fig. 1.—Placement of temporal electrodes. The subsequent figures were obtained by means described elsewhere in the literature.[5, 6] Each time a muscle contracts, a minute electromotive force is generated. With suitable electrodes and amplifiers this e.m.f. may be picked up and its signal recorded. Electromyographic research is based on the assumption that the e.m.f. generated by muscle contractions varies according to the contractions of the muscles.

arc like that seen in the spinal cord. When all the muscles capable of moving the mandible demonstrate no other contractions than those necessary to hold the bone in a balanced position against gravity, a state of equilibrium is maintained (Fig. 3). The physiologist calls this the postural position of the mandible. The dentist calls it the physiologic rest position of the mandible. The latter term is a poor one, for the position is no more physiologic than any other mandibular position, and the muscles are not at rest.

Postural reflexes are primitive and unlearned. A series of seventeen neonates have been studied during the first three days of postnatal life. It could be demonstrated electromyographically that each child already had a postural reflex. This is not surprising since a starting point is needed for some of the reflex movements of the mandible during sucking, swallowing, coughing, etc. Perhaps this is the only postural reflex fully developed so early. Few others would be needed until the infant began to sit upright, move his limbs, stand, and walk. Many of the most highly developed reflexes involving skeletal muscle at birth are concerned with basic matters of survival such as breathing, feeding, and protection of the air passage. All such reflexes involve the use of the fifth nerve musculature, with the postural position of the mandible as the starting point for all movements involved.

**Fig. 2.—Typical electromyographic equipment; ink-writing recorders on the left, amplifiers and controls in center, and audio unit on the right. This is the equipment the author used in the Department of Physiology, College of Medicine, State University of Iowa.**

Only the postural position is consistently observed prior to the eruption of the teeth. Sillman[1,2] spoke about the development of an "occlusal sense" as the erupting primary teeth first met their antagonists of the opposite jaw. This "occlusal sense" is the formation of the neuromuscular reflex establishing centric relation. Centric relation has been spoken of as if it were a morphologic trait like big ears or blue eyes. But since it is not present at birth, it must come later, either through learning or the acquirement of neuromuscular features not present at birth. The postural position is easily recorded in the neonate, but repeated efforts to locate centric relation met with failure until the age at which the primary

occlusion was established. As the teeth occlude, afferent impulses of touch and pressure are transmitted through the mesencephalic root of the fifth cranial nerve to the brain where they may alter and affect the motor impulses being transmitted to the muscles controlling the position of the mandible. After the teeth have erupted, the muscles learn one position of occlusion providing a maximum of occlusal contact and minimum of torque or lateral stress and strain on the roots of the teeth. This is the beginning of centric relation. The muscles alone could not establish so precise a mandibular position, while they are contracting. But the intercuspation of the teeth makes it possible for the brain to learn quickly this new mandibular position. Centric relation is established during the early stages of the primary dentition when occlusal anomalies are at a minimum. At the beginning, centric relation and centric occlusion are identical. *Centric relation is the first established neuromuscular reflex concerning mandibular position when the teeth are in occlusion.* The centric relation reflex is controlled not only by the stretch

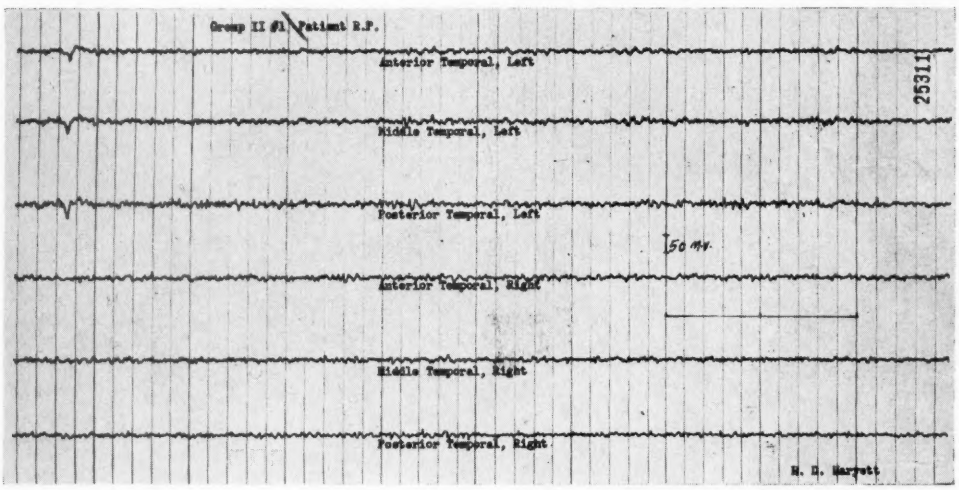


Fig. 3.—An electromyographic record from the temporal muscles while the mandible is in its postural position.[8]

receptors in the muscles of mastication, but by the receptor organs in the periodontal membranes as well. The periodontal receptors demand a high degree of localization of mandibular positioning. It seems important that the postural position is maintained by the myotatic reflex alone, while the centric relation involves both muscles and the periodontal membranes for its maintenance. Centric relation involves more neuromuscular activity, since the mandible must be held in elevation above the postural position in a position permitting occlusal harmony (Fig. 4).

The anteroposterior limits of centric relation are defined first, since the primary incisors erupt first and restrict mandibular movements in this one direction only. Later, the teeth in the lateral segments of the dental arch inhibit mediolateral positioning, and thus help localize the limits of centric relation in this other direction. The vertical limits of centric relation are never so precisely defined. The least displacement of the mandible, anteroposteriorly or mediolaterally, immediately

sets off a shower of afferent impulses which elicits a motoneuron response stabilizing the mandible in these two directions. Greater mandibular displacement is necessary vertically for a similar response to occur. Opening changes in vertical position of the mandible cause only the firing of stretch receptors and do not, of course, cause stimulation of the periodontal receptors. Direct biting pressure in line with the long axes of the teeth has little effect, but the slightest angular vector of force against a tooth elicits a response from the periodontal proprioceptors. This helps explain the more precise limits of centric relation anteroposteriorly and mediolaterally. It also explains why we have somewhat more latitude in changing vertical dimension than in shifting the mandible horizontally.

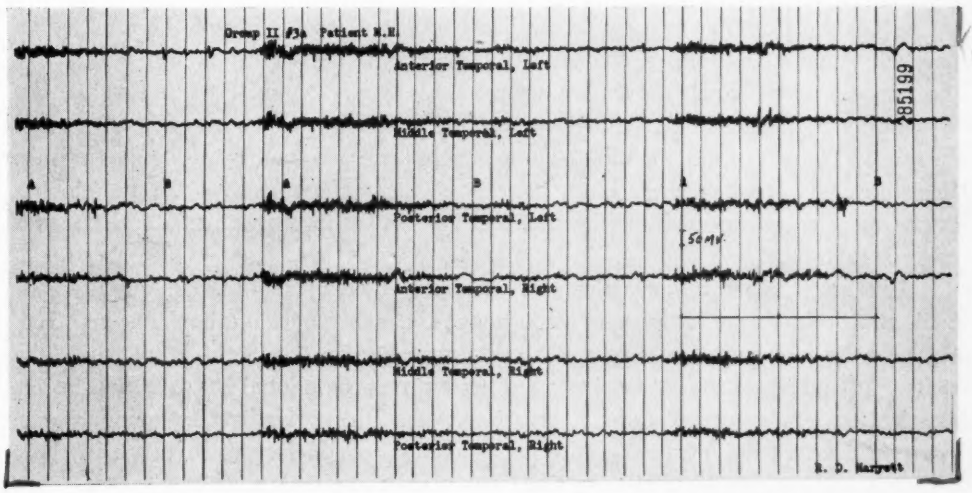


Fig. 4.—An electromyographic record from the temporal muscles as the mandible is moved from the postural to the occlusal position.[8] This occlusal position permits muscle balance, hence it is centric relation.

## DEFINITION OF CENTRIC RELATION

Most definitions of centric relation in common usage today seem physiologically untenable. Definition is done usually by describing where some landmark might be or, what is worse, where some person wishes that landmark to be. Another favorite method of definition is to describe a method of recording the relationship. Most present definitions fail to account for the variability always seen in biology. If there is one and only one position for centric relation in all of mankind, then it is the first trait discovered which behaves so singularly. We expect people to vary in height, weight, complexion, eye color, and tooth size. Why not in mandibular position?

Kingery[3] has wisely pointed out there are two problems in centric relation: defining it and registering it. It is difficult to see how one can accurately register that which he defines wrongly. It would seem to this writer that centric relation would have to be defined in terms of neuromuscular reflexes.

*Centric Relation* is the position of the mandible as determined by the neuromuscular reflex first learned for controlling the mandibular position when the primary teeth were in occlusion.

*Centric Occlusion* is the relationship of the teeth during centric relation.

Both the postural position and centric relation may be registered by reference to bony or dental landmarks, any landmarks on the mandible. Such references are of use in registering centric relation and the postural position, but they do not define the terms. They each must be defined in terms of neuromuscular reflexes for that is what they are.

## ALTERATIONS IN THE REFLEXES CONTROLLING MANDIBULAR POSITION

Since the mandible is a single midline bone, any contraction of the muscles on one side must necessitate a compensating reflex in the corresponding muscles of the opposite side. Each movement brings into play a highly coordinated pattern of synergy. All mandibular movements are effected by the contraction of several muscles. There are no mandibular movements carried out by a single muscle. In a like fashion when there is an alteration or interference with the functioning of the muscles on one side of the mandible, an upset in the contralateral reflexes must be seen too.

Like most other reflexes these are capable of being suppressed, inhibited, or facilitated, though we know very little about the neurologic mechanisms involved. Perhaps the many uses of the face have an influence on the methods by which the reflexes are altered. The face is used to express emotional states, for speech, mastication, swallowing, coughing, breathing, etc. The myriad reflex combinations, synaptic connections, nervous pathways, and psychologic factors involved in these activities are enough to challenge the most vivid imagination.

During growth of the craniofacial complex of bones, centric relation must change, for the mandible grows at a faster rate downward and forward than do the maxillae. Centric relation is not the same when one is tense and tired as when one is freshened and relaxed. It is different when one is afraid than when quiet and at ease. Since centric relation is a neurologic concept, the reflexes controlling centric relation must have been learned and be capable of some learning. Both the postural position and centric relation become relatively more stable with age, but the concept of a fixed and immutable centric relation is contrary to all that is known of neuromuscular physiology.[4] Pain in either the dental or the joint region will result in a remarkable and dramatic effect upon the muscle action. The result is usually "splinting" of all the muscles capable of moving the joint. This phenomenon is a continuous contraction of all the muscles in order to immobilize the joint, and thus avoid further pain which might be caused by movement.[5]

Perhaps the most intriguing alterations in the basic reflex patterns are those which arise due to altered or impaired occlusal harmony. These changes have great clinical significance from early childhood on. As each primary tooth is lost, it is followed by a permanent successor that is different in size and shape from its predecessor. During the mixed dentition stage, occlusal interferences

are many, and the muscles must repeatedly learn new patterns of mandibular closure to avoid interfering teeth.[6] The pathways of centric relation, having only been established in the central nervous system a short time, are not as firmly entrenched as in the adult. The constant adaptation to new stimuli is frustrating to the muscles, hence the difficulties usually encountered in reliably recording centric relation in children. It is at this time that the muscles frequently adopt an occlusal position that does not coincide with centric relation. It is important to remember that no repeatedly used position of occlusal contact which does not coincide with centric relation is ever acquired by chance. All are learned neuromuscular reflex patterns forced on the masticatory system (Figs. 5 and 6). These new positions of occlusal contact usually begin as expedient processes for avoiding interferences and providing better function than centric relation offers at the moment. The continued presence of the occlusal disharmony, as in the case of a severe malocclusion, causes the new reflex pattern of pathways to be used so repeatedly that the new position of the mandible may resemble centric relation. This acquired position may be termed "the usual position of occlusal contact." The use of such terms as "acquired centric, new centric," etc., seems ill-advised, for the position is not centric relation. It would also seem redundant to speak of "true centric" or "original centric." The adjective "centric" should be used to refer to one position only. All positions of occlusal contact, other than centric occlusion, to which the patient repeatedly returns, are properly and simply termed eccentric occlusal positions. The earlier in life an eccentric occlusion is adopted and used, the firmer the hold on the nervous system, for it is simply a habit. Also, it is more difficult in adulthood to locate centric relation and restore normal masticatory functioning. This is the most forceful argument for eliminating tooth interferences in the primary dentition and for early orthodontic treatment (Fig. 7). The effects of these abnormal muscle reflex patterns upon the growth of the craniofacial skeleton is not yet fully known.

### LOSS OF TEETH AND ITS EFFECT ON MANDIBULAR REFLEXES

Later in life, the most frequent causes of abnormal reflex patterns are poor restorative dentistry and the loss of permanent teeth. The tipping of adjacent teeth into edentulous spaces causes occlusal interferences, which necessitate the learning of new muscle reflexes, and the establishment of an occlusal eccentricity. As more teeth are lost, different eccentric positions are learned, some of which are so severe as to cause strain on the temporomandibular articulation. Sensory impulses from the joint region are thus added to the afferent periodontal impluses, and play a role in determining the occlusal relationship.

### CENTRIC RELATION IN THE EDENTULOUS PATIENT

Any patient presenting for complete denture prosthesis has suffered from a poor occlusal history, or he would not be needing prosthetic service. A high percentage of such patients must have practiced various eccentric patterns for years prior to the loss of all of their teeth. While teeth are in the mouth, the periodontal membranes serve as an important source of afferent signals for muscle regulation. Once the teeth and the enclosing periodontal membranes are lost, the position of

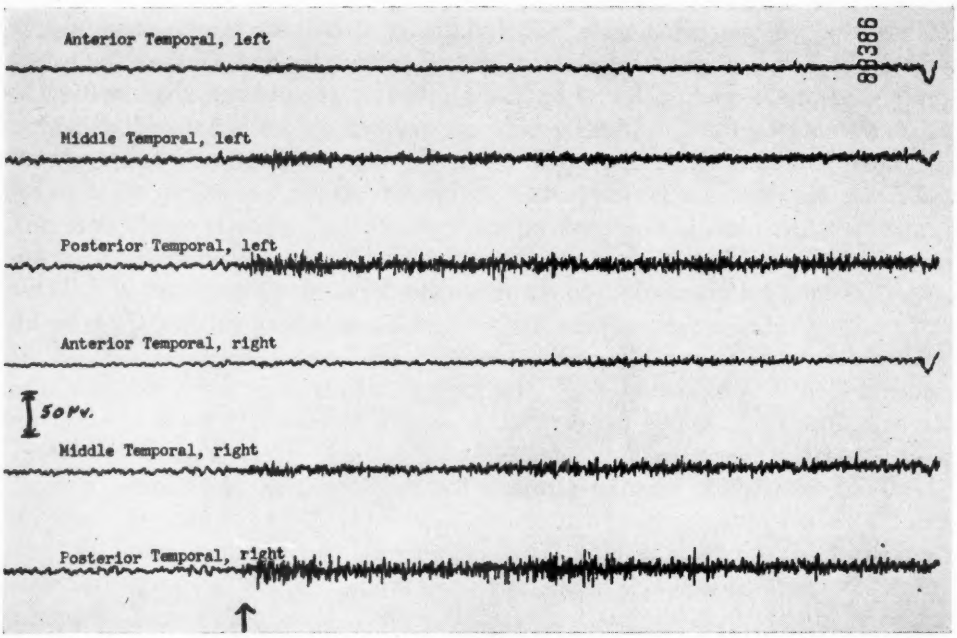


Fig. 5.—An electromyographic record from the temporal muscles as the mandible is moved from the postural position to an eccentric occlusal position. Note the muscle imbalance caused by the lack of occlusal harmony.

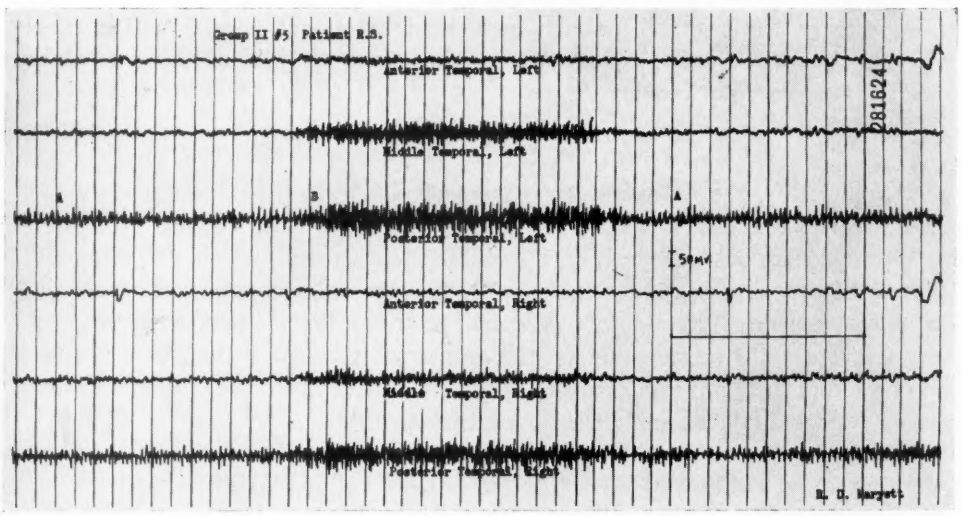


Fig. 6.—An electromyographic record from the temporal muscles as the mandible is moved into an eccentric occlusal position.[8] Note the muscle imbalance at all times. The postural position is not recorded since the severe occlusal disharmony has taught the muscles to anticipate the tooth interferences, even before the mandible reaches the height of the postural position.

the mandible is determined almost solely by the proprioceptors within the muscles and the capsular ligament.

The primary aim in registering centric relation in the edentulous patient is to do away with any eccentric reflexes which might have been used. We use wax, not only to record the relationship observed, but also to insulate the teeth of one jaw against those of the other (Fig. 8). Muscle exercises prior to recording centric relation are another physiologically sound device for causing a temporary forgetting of the eccentric pattern (Fig. 9). Drugs, e.g., Mephenesin, patient relaxation, jiggling the chin, etc., are all used as means to the same end, viz., a temporary erasure of the unwanted reflex. Obliteration of the superposed eccentric reflex allows the more basic reflex of centric relation to act in a free and uninhibited manner. If the centric relation is registered prior to the extraction of the last remaining teeth, the eccentric reflex itself must be overcome. However, after extraction of all of the teeth, it is only necessary to overcome the memory of the eccentric reflex, since the primary source of stimulation for the afferent arm of the reflex was lost with the periodontal membranes.

The memory of previous eccentric positions, positions necessitated by tooth interferences, may persist for some time. However, in the absence of periodontal stimulation, those mandibular positions assumed to avoid occlusal disharmony will eventually be forgotten. They will be forgotten unless, of course, they are perpetuated by dentures constructed to erroneous mandibular relationships. The loss of the periodontal membranes may leave the musculature frustrated if no firm imprint of one continuously practiced occlusal position persists in the muscle memory. On the other hand, if the dentures first constructed allow a maximum opportunity for muscle adjustment, the muscles may recall and revert to a position near what would have been centric relation had more favorable conditions obtained and teeth not been lost.

There is no evidence that centric relation in the 60-year-old patient is precisely where it was in that same patient when he was 20. Even when ideal conditions have been maintained at all times, the natural aging of tissues and bodily processes must produce minor changes in the relations of bony parts, the contractility of muscle fibers, the pattern of synaptic discharges, etc. Life is change, for as Bruce Barton said, "When you're through changing, you're through."

However, most denture patients do not demonstrate clinically important changes in centric relation attributable to the aging process. The problem in centric relation in the edentulous patient is simply how to discriminate centric relation from other mandibular relationships which may have been used more while the natural teeth were still in the mouth.

The reversion to the use of centric relation in place of an eccentric relationship occurs only when the precipitating mechanisms for the eccentric reflex are lost. Though the periodontal membranes go quickly when the teeth are extracted, the muscle may rely on memory for a while. It would thus seem important to allow a maximum of occlusal freedom in immediate dentures, particularly for anteroposterior and mediolateral adjustments. There is physiologic evidence to support those clinicians who construct immediate dentures with cuspless posterior teeth and a minimum overjet.

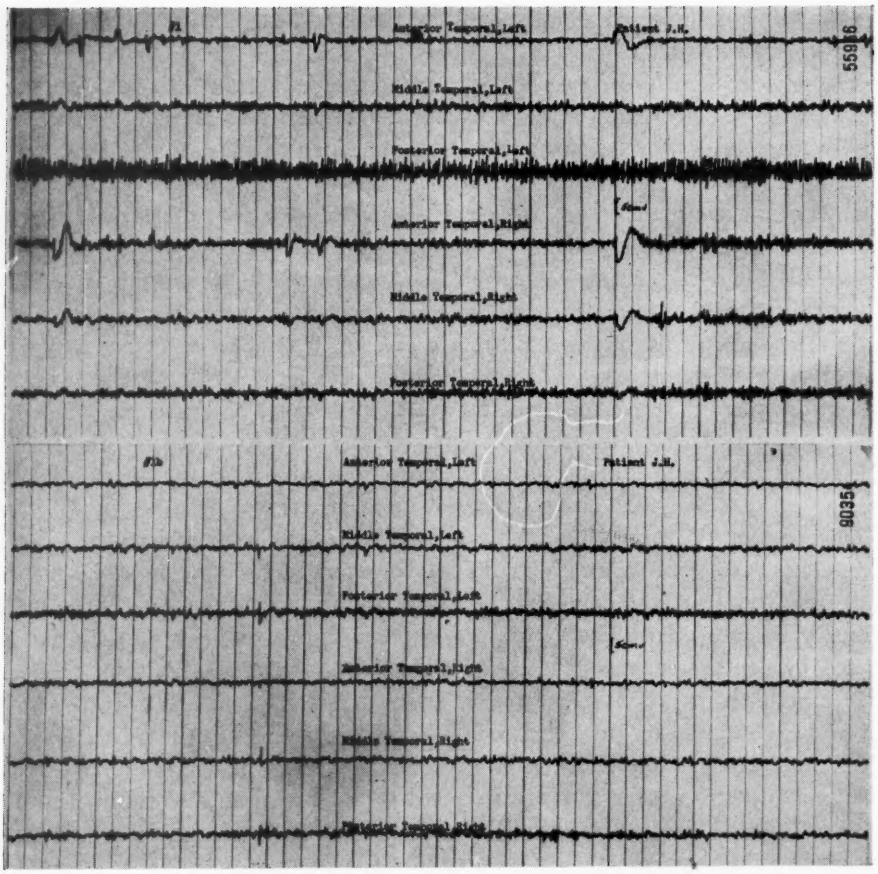


Fig. 7.—An electromyographic record before and after orthodontic treatment. The harmonious muscle pattern is indicative of a tooth alignment which will likely retain well.

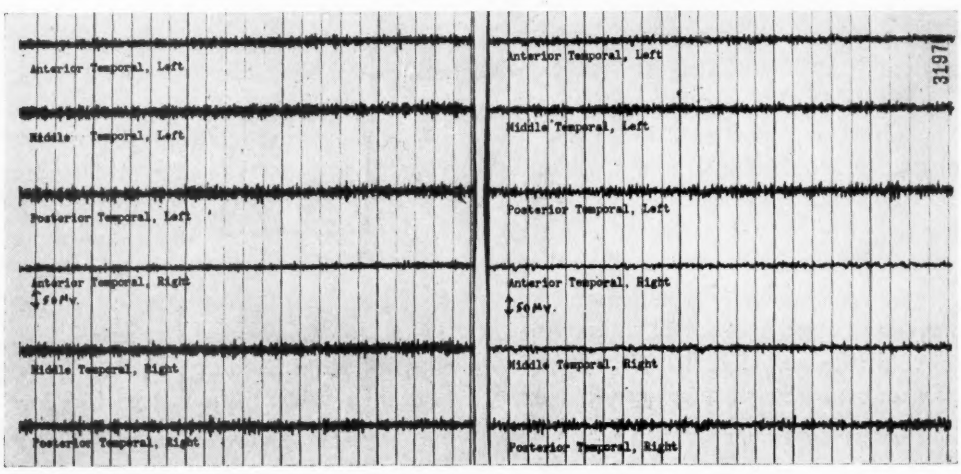


Fig. 8.—The effect of wax between the teeth on muscle action during occlusion. Left, Occlusion without wax. Right, Wax between the teeth yet registering the same occlusal position.

In mouths in which an extreme eccentricity or series of eccentricities have been used, it may be good practice to teach the patient a completely new mandibular closure pattern and position, e.g., successful dentures may be constructed on a "hinge axis" even though the patient may not have used such a closure pattern previously. Such a procedure is defensible clinically as well as physiologically. But there is no reason to confuse this newly learned mandibular position with centric relation. It may or may not be centric relation. To the writer's knowledge,

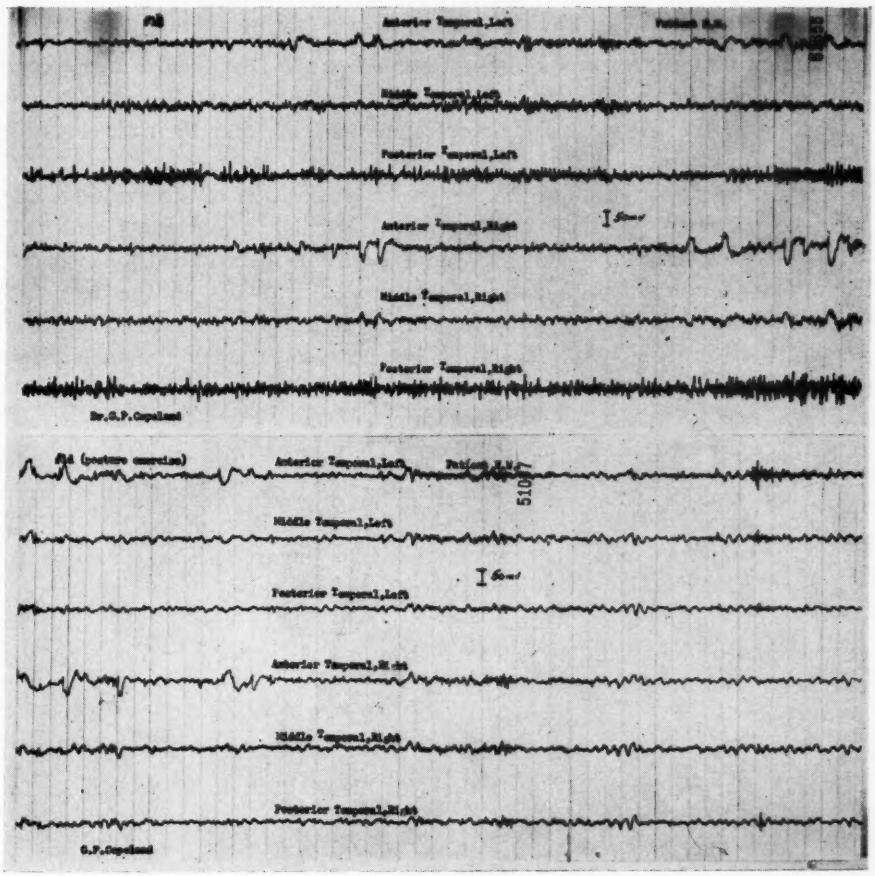

Fig. 9.—The effect of muscle exercises on the muscle pattern during occlusion. Above, Before exercises. Below, Shortly after exercises. In a few moments the original pattern will again be seen unless the interferences are removed.

there is no convincing evidence that the most retruded position of the condyles from which lateral movements may be made coincides in all patients with centric relation, except by definition. My own experiments have shown that 76 per cent of the subjects observed demonstrated muscle imbalance and straining when the jaws were closed with the condyles in their most retruded positions. These data have been obtained from some 1,100 observations taken electromyographically. There are important age considerations in this matter. Only rarely does a retruded position show relaxed musculature in children, but as the mandible ceases its growth upward and backward, more subjects demonstrate this phenomenon. Even in the

edentulous subjects, only 32 per cent have shown muscle relaxation and balance when the condyles are in their most retruded position. These figures support well the work (laminographic) of Rickets.[7] In my opinion, the greater the occlusal disharmony the more likely centric relation is to be found somewhere other than in the most retruded position, simply because greater joint mobility develops with eccentric occlusions.

## REGISTERING CENTRIC RELATION

The foregoing concepts have some bearing on the methods used for recording centric relation and the postural position of the mandible. The aim is to catch the pure reflex pattern, for any alteration invites error. Due regard must be given to the psychologic factors involved, such as the patients' fears and apprehensions, their reaction to the gadgetry and impression material, and their tiredness. By far the most important fact to bear in mind is that these are neuromuscular reflexes singular to the patient, not the dentist. The position of the mandible of any patient is determined by that patient's neuromuscular mechanisms and not by the dentist's paraphenalia. Nor are these positions determined by where the dentist wishes they might be. Jaw relations are not provided by the dentist, they are registered by the patient. Any successful technique works, not because of the ingenuity of the engineering involved, but because of adherence to physiologic facts.

## SUMMARY

The postural position of the mandible is the only reflex determining mandibular position present at birth. Centric relation is learned after the teeth errupt: it is the first learned reflex determining the occlusal position of the mandible after the primary dentition is complete. Eccentric mandibular positions are learned as expedient mechanisms for avoiding occlusal disharmonies. They are forgotten when the source of the afferent impulses prompting them is removed. Centric relation in the edentulous adult is determined by muscle proprioceptors largely, and thus presents slightly different problems in registration.

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# THE INFLUENCE OF PARTIAL DENTURE DESIGN ON DISTRIBUTION OF FORCE TO ABUTMENT TEETH

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MANY MEN HAVE contributed to the progressive advancement of partial denture service and have written extensively to document their experiences and philosophies in this field. Their objectives are universal—to provide means of restoring function, esthetics, and comfort in a manner which promotes and perpetuates oral health. Toward this end, increasing attention is directed to the necessity for development of treatment plans which are based upon the associated biophysical factors. These plans include thorough examination, accurate diagnosis, and sound appraisal of the various structures which will assume the stresses to be placed upon them by the denture. Design of the appliance plays an important part in the scheme, because it is through the structure of the denture that the forces of mastication are transmitted from the occlusal surfaces of the artificial teeth to the natural teeth and ridges.[1] Judicious dispersal of the forces by limited loading in selected areas is deemed essential. It is felt, generally, that designs which provide for broad bases, rigid connectors, multiple rests, and properly selected retainers are most likely to effect favorable distribution of force and maintain the integrity of the periodontal and ridge tissues.

The literature pertaining to stress distribution has been summarized capably by Steffel.[2] He found that there are three major schools of thought which influence practical procedures in the planning and construction of partial dentures. One utilizes stress breakers as a means of loading the tissues selectively. The second equalizes the stresses between teeth and ridges through functional basing of the denture. The third looks to broad distribution of the forces to prevent tissue overloads. Although logical reasoning was presented to justify the theories advanced in each of more than one hundred writings which Steffel reviewed, no substantiating research was reported. This is unfortunate in that scientific data have not been accumulated by which the various elements involved in partial denture design can be compared or evaluated. To fill this gap and to insure maximum protection to "that which remains," investigations must be conducted to determine the extent to which the distribution of force can be controlled by the operator. It is especially

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important to know exactly how much the dispersal of force is influenced by varying such factors as the type of retainer, number and location of rests, contour and rigidity of connectors, use of stress breakers, extension of bases, and functional basing of dentures.

This study which was conducted under laboratory conditions had as its specific objectives: (1) the determination of the magnitude of forces imparted to abutment teeth when known loads were applied to a denture modified to produce a series of differing designs, and (2) the measurement of relative movement of the abutment teeth in a horizontal plane during application of these forces.

## DENTURE SETUP

The lower distal extension partial denture was selected for analysis because, being one of the most frequently used prosthetic restorations, it represented a typical treatment problem, and, since it required only two abutment teeth, it posed a relatively simple problem for the initial study.

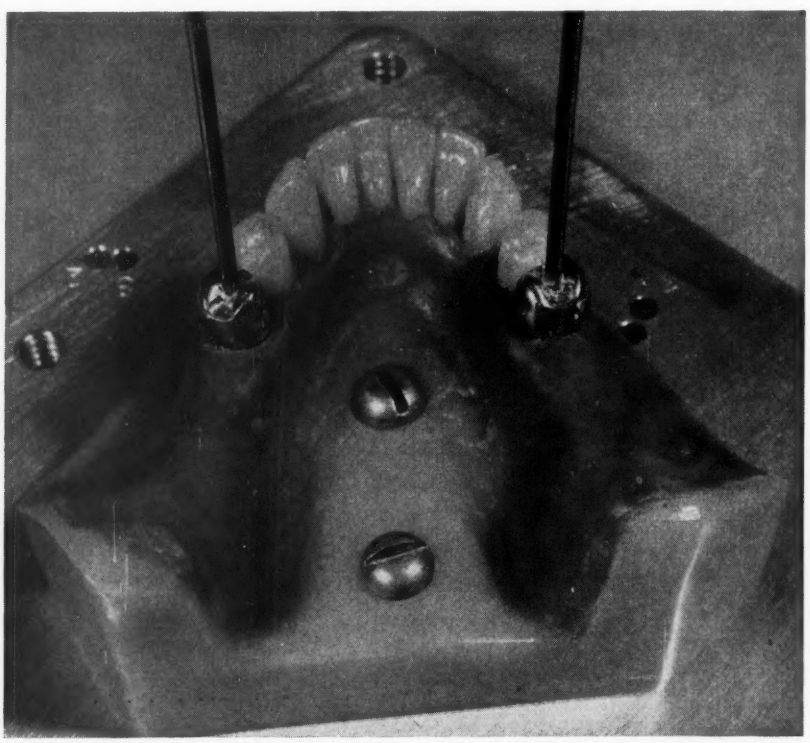


Fig. 1.—The acrylic resin testing model with a resilient covering of the gingival and ridge areas. The roots of the teeth are coated with the same pliable material to permit individual tooth movement.

To create the desired situation of a partially edentulous lower arch with all anterior and bicuspid teeth in position, an acrylic resin model was constructed (Fig. 1). The gingival and ridge areas were covered with a layer of pliable acrylic resin material which simulated the resilience of natural tissues. A thin coating of

the same plastic was applied to form a pseudo-periodontal membrane about the roots of the specially fabricated acrylic resin teeth. This construction permitted a slight movement of the individual teeth and of the ridge covering.

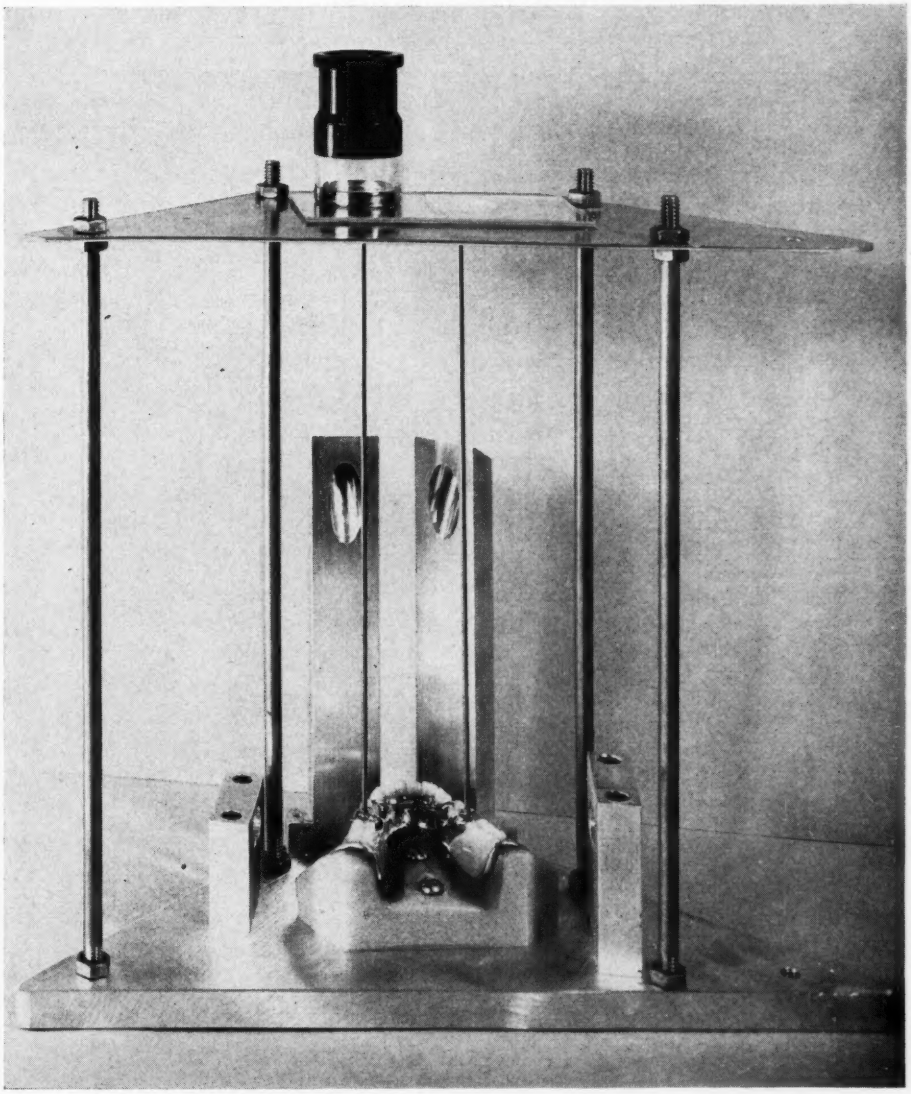


**Fig. 2.—The testing assembly with the model in position. Metal rods which serve to magnify movement of the abutment teeth extend into the top of the frame. Movement is measured with a calibrated comparator.**

Upon completion of the model, an "overdesigned" partial denture was fabricated for use with modifications throughout the tests. The basic denture incorporated all possible bracing and supporting elements to distribute the forces as widely as possible throughout the teeth and ridges. The design included conventional circumferential clasps with rests at the distal marginal ridges of the abutment teeth, and additional rests bearing upon all other marginal ridge areas.

A broad rigid connector in the form of a lingual plate was employed to join the bases and other parts of the appliance. The bases were made of cast metal to assure accurate adaptation to the ridges and were extended fully upon the retromolar pad and buccal shelf areas.

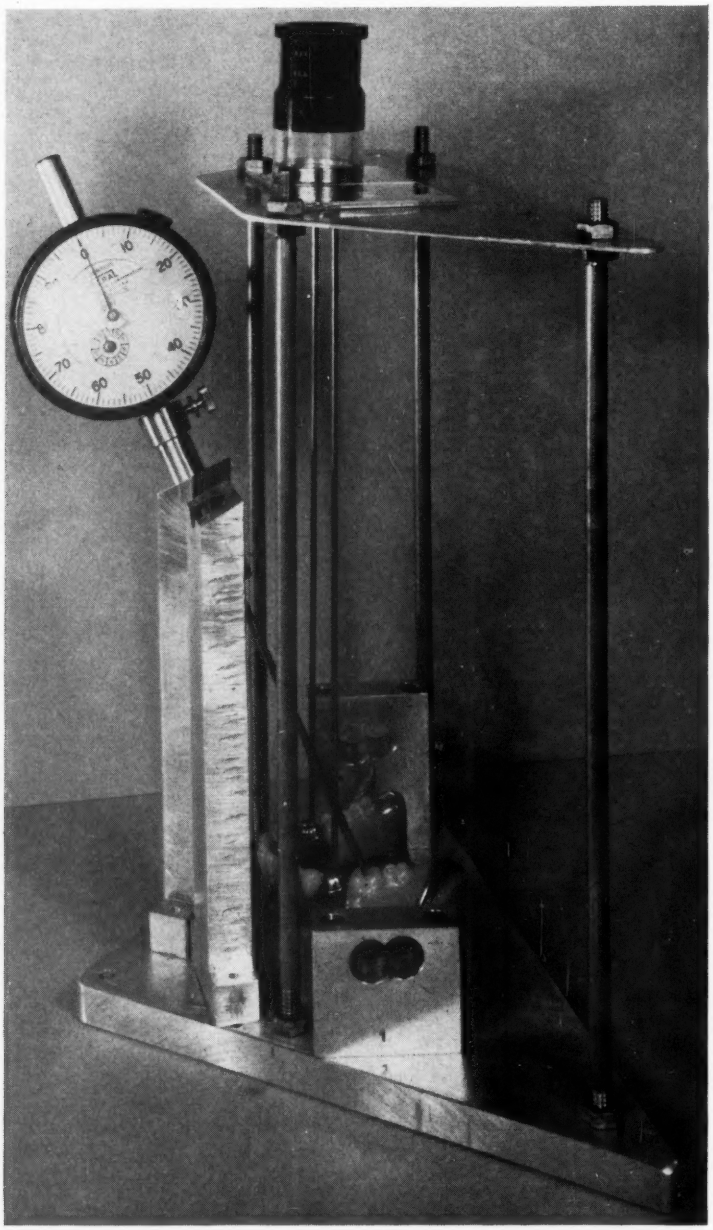


Fig. 3.—The pressure gauge in position for loading of the lower left first molar.

## TESTING SETUP

A major requirement in conducting the tests was that it be possible to apply any desired pressure to selected points on the denture in an accurately repeatable manner. This was accomplished by mounting the testing model with a set of interchangeable jigs in the assembly shown in Fig. 2. Through the use of the jigs, a pressure gauge could be guided with precision to each of the molars of the left side in four predetermined directions (Fig. 3).

Although the limited movement of the abutment teeth which occurred during the application of force could have been measured directly at the tooth, it seemed desirable to magnify the movement to simplify the measuring procedure, and to insure its accuracy. The magnification was obtained through the use of thin steel rods which were cemented in the crowns of the abutment teeth. Each rod was 9 inches long and extended upward in line with the long axis of the tooth.

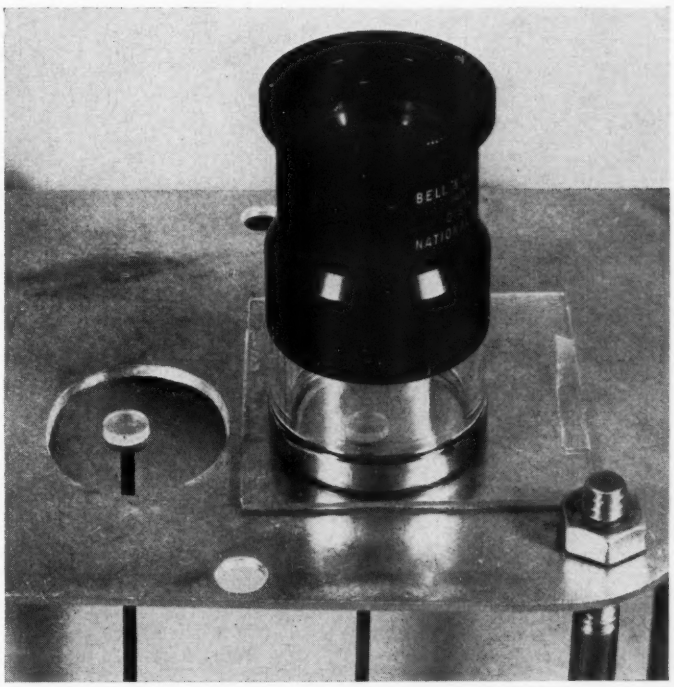


Fig. 4.—Disks with engraved crosshairs cemented to the ends of the rods. Matching crosshairs on the overlaid slide are reference lines for measurements with the comparator.

At the upper free end of each rod a plastic disk with an engraved crosshair was attached to provide a line of reference for measurement (Fig. 4). Matching reference lines were scribed on transparent slides which were oriented on the top of the mounting frame directly over the plastic disks. When the reference lines were viewed from above, the relative movement of the abutment teeth could be determined by the direction and distance which the plastic disks traveled during the application of pressure. The measurements, in units of five-thousandths of an inch, were made with a calibrated comparator.

APPLICATION OF PRESSURE

It was felt that much could be learned regarding tooth movement and distribution of force by various parts of the denture if pressures were applied to represent not only the chewing force, but also the extreme components of the force. This was accomplished by applying pressure from four directions to the first and second molars of the left side of the denture. The first application of pressure (15 pounds) was made in a direction which could be considered as the composite of a diagonal chewing stroke and a hinge closure, as indicated in Fig. 5. Of the

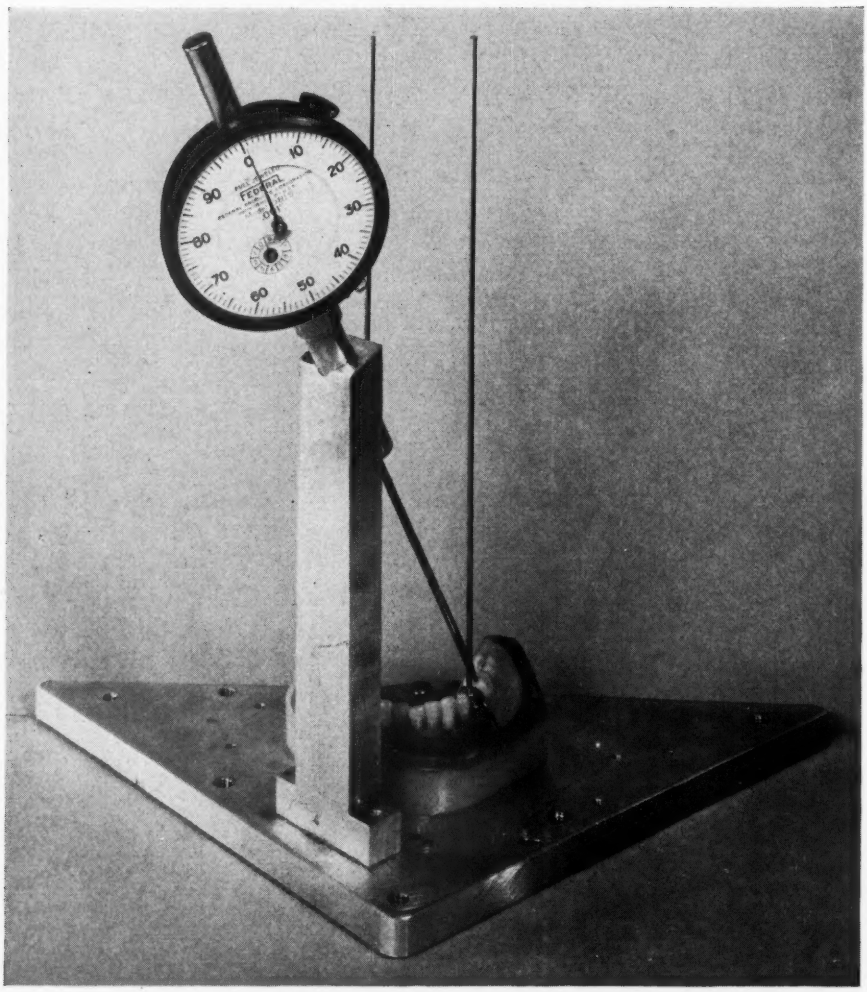



Fig. 5.—Assembly broken down to show manner in which pressure was applied to simulate loading during mastication. The direction is a composite of a diagonal chewing stroke and a hinge closure.

four loadings used, this most nearly simulated the force applied for crushing during mastication. The other loadings were not directly related to chewing, but were included to determine how forces nearest to the vertical and horizontal extremes are distributed through dentures of varied designs. The investigation of pure horizon-

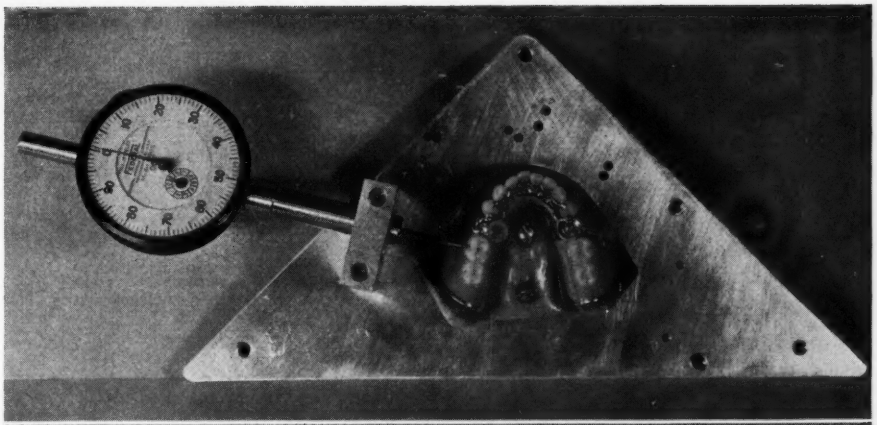


Fig. 6.

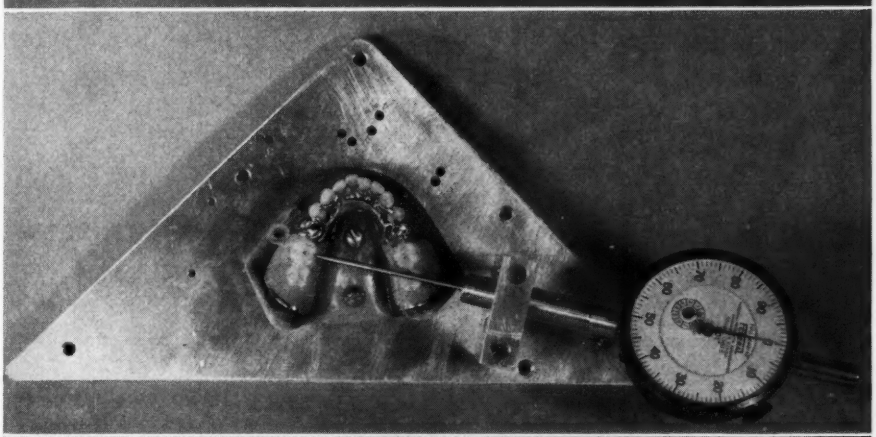


Fig. 7.

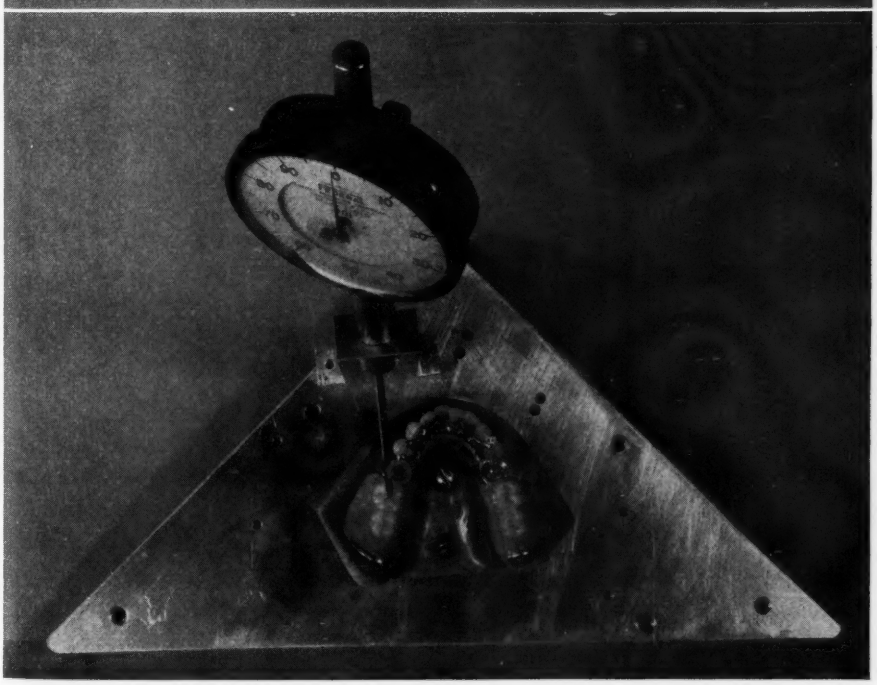


Fig. 8.

Fig. 6.—The pressure gauge in position for the application of force horizontally from the buccal side.

Fig. 7.—The pressure gauge in position for application of force horizontally from the lingual side.

Fig. 8.—The manner of applying force to simulate pressure occurring during simple hinge closure.

tal force distribution was considered to be of special interest because of the common belief that horizontal components of masticatory forces are the most damaging to periodontal and ridge tissues. Simple horizontal pressure (4 pounds) for this study was applied to each molar of the left side from both buccal and lingual directions at right angles to the long axis of the ridge (Figs. 6, 7). The "vertical" pressure (15 pounds) was directed vertically in the frontal plane and in line with a hing axis closure in the sagittal plane (Fig. 8). This application of force simulated to some extent that which occurs against a bolus of food during upward movement of the mandible without translatory shifting of the condyles.

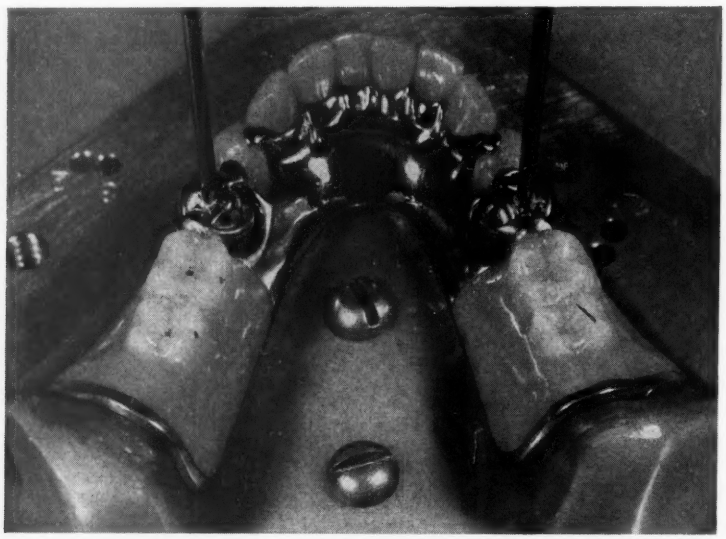


Fig. 9.—The original denture in position. Note the broad lingual plate connector, rests at all marginal ridge areas, and full extension of the bases.

## PROCEDURE

The partial denture, as originally designed, was placed upon the testing model, and pressures were applied to the molars of the left side as previously indicated. The direction and distance which each abutment tooth moved from its static position during each application of pressure were recorded. Upon completion of the first set of measurements, six alterations were made in the design of the denture, with loading and measuring procedures being repeated after each alteration. All modifications, including refinishing, were accomplished under water to prevent generation of heat and development of strains in the casting. The altered surfaces were smoothed with abrasive wheels but were not polished.

The various designs of the appliance as they existed throughout the series of tests were as follows:

1. The original denture (Fig. 9).
2. The double rests bearing upon the first and second bicuspids of each side were removed (Fig. 10).
3. The rests bearing upon the mesial marginal ridges of the first bicuspids were removed (Fig. 11).

4. The lingual plate connector was altered to form a lingual bar and continuous lingual rest (Kennedy strap) (Fig. 12).

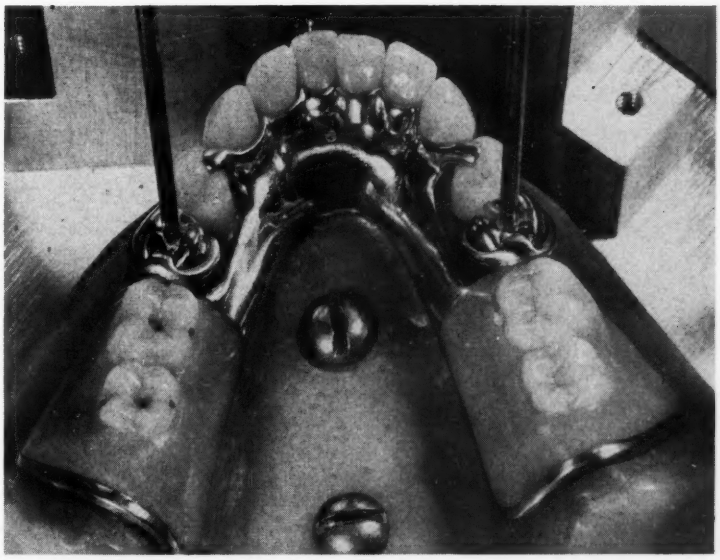


Fig. 10.—The double rests removed from each side of the denture.

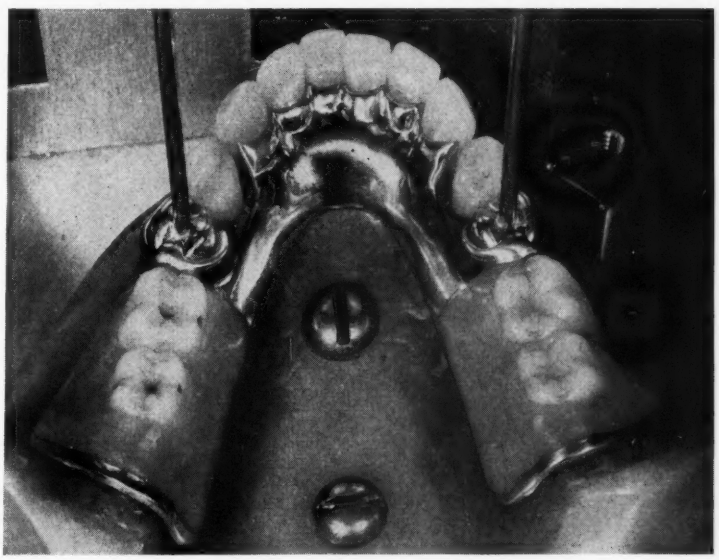


Fig. 11.—Both first bicuspid rests removed.

5. The continuous lingual rest was removed, leaving the relatively rigid cast lingual bar to serve as the connector (Fig. 13).

6. The lingual bar was reduced to develop flexibility comparable to that of a wrought lingual bar (Fig. 14).

7. The size of the denture bases was reduced to create underextension such as is observed frequently in practical dentures (Fig. 15).

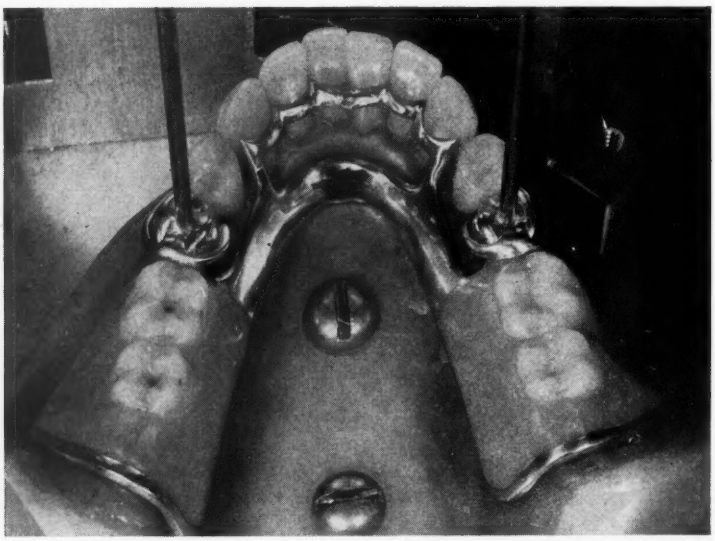


Fig. 12.—The connector modified to form a lingual bar and continuous lingual rest.

The measurements which were obtained during the tests permitted charting of the movement of each amplifying rod during the application of pressure. Each point plotted was indicative of the direction and relative movement of the abutment tooth but, of course, did not reveal the magnitude of the force which produced the movement. For that purpose it was necessary to develop conversion graphs which related tooth movement to applied pressure. The data required for the graphs were obtained without the denture in position. The model and testing assembly were secured upon a rotary table in such a way that one abutment tooth was centered on the table's axis of rotation. Then, with the pressure gauge being guided toward the axis by a jig attached to the base of the table, a series of known pressures were applied to the circumference of the tooth at intervals of 22.5 degrees (Fig. 16). Movements of the rod attached to that tooth were charted, and the conversion graph was prepared. The entire procedure was repeated for calibration of the other tooth (Fig. 17).

## OBSERVATIONS REGARDING TOOTH MOVEMENT

*Pressure Applied as in Chewing Stroke* (Fig. 18).—

1. Both abutment teeth moved posteriorly to the left in the general direction of the force until rigidity of the connector was reduced by modification of the lingual plate and by each subsequent alteration. With these changes, posterior movement of the right tooth decreased markedly, and the effect of torque or

rotation of the appliance about the left tooth was evident, even to the point of carrying the right tooth anterior to its static position.

2. Similar but much less movement of the abutment teeth occurred when pressure was applied to the second molar than when applied to the first molar.

Fig. 13.

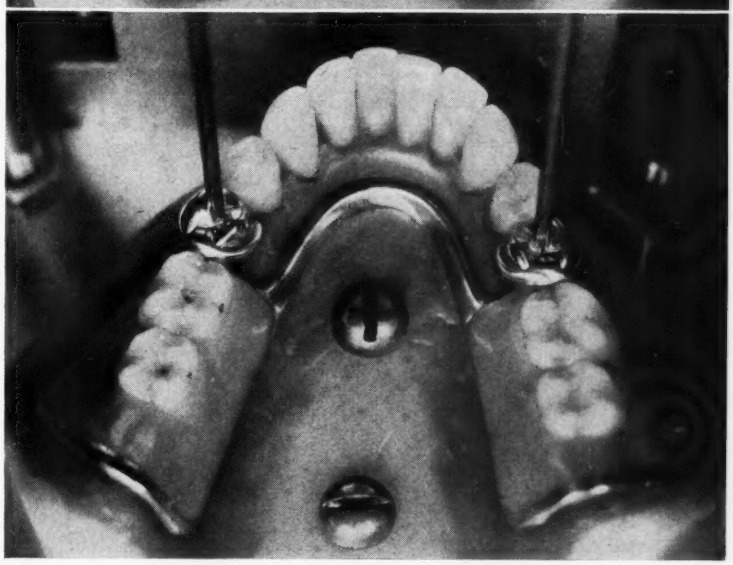


Fig. 14.

Fig. 13.—The continuous lingual rest removed, leaving a relatively rigid lingual bar.
Fig. 14.—The lingual bar reduced to create flexibility comparable to that of a wrought bar.

3. The greatest increases in movement of the abutment teeth occurred after the removal of the double rests, after the removal of the continuous lingual rest, and after the reduction of the size of the denture bases.

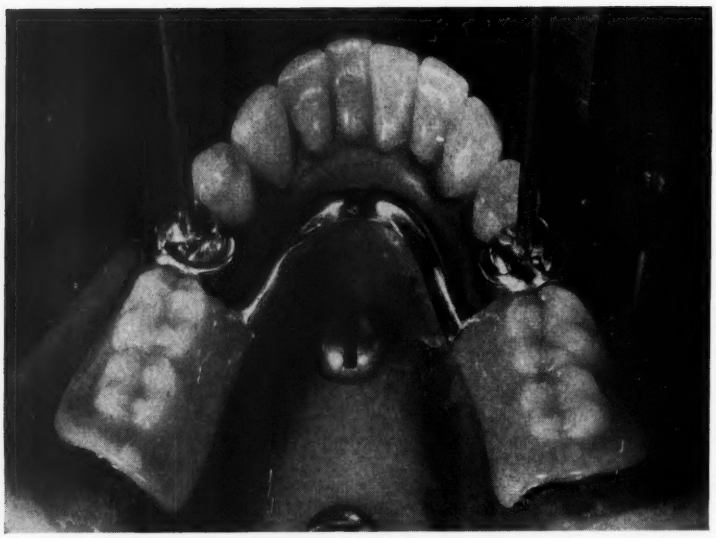


Fig. 15.—The denture bases reduced in size to create underextension.

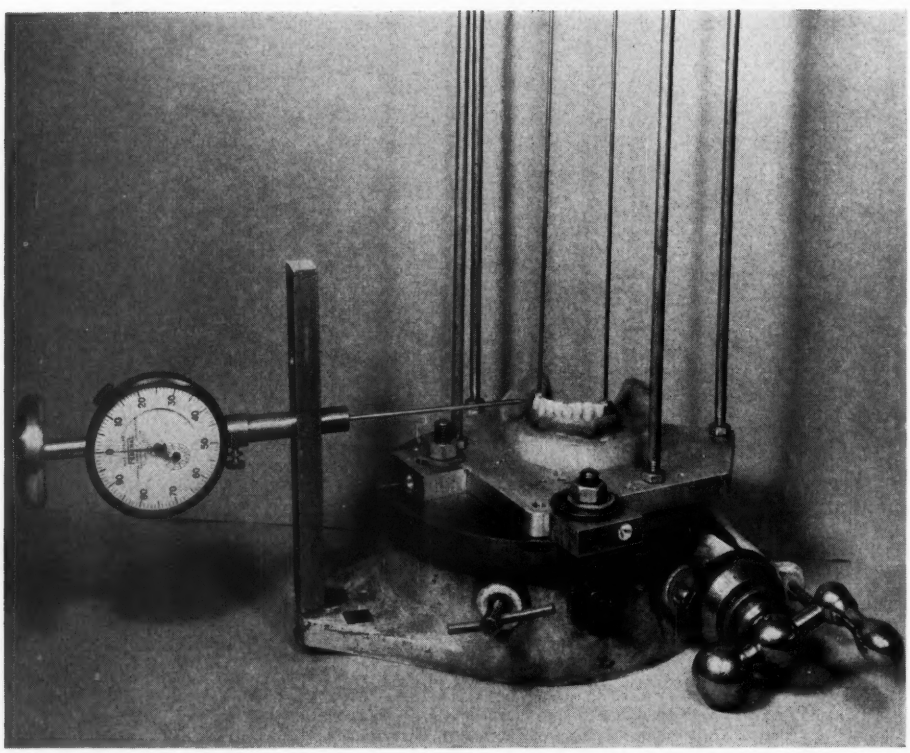
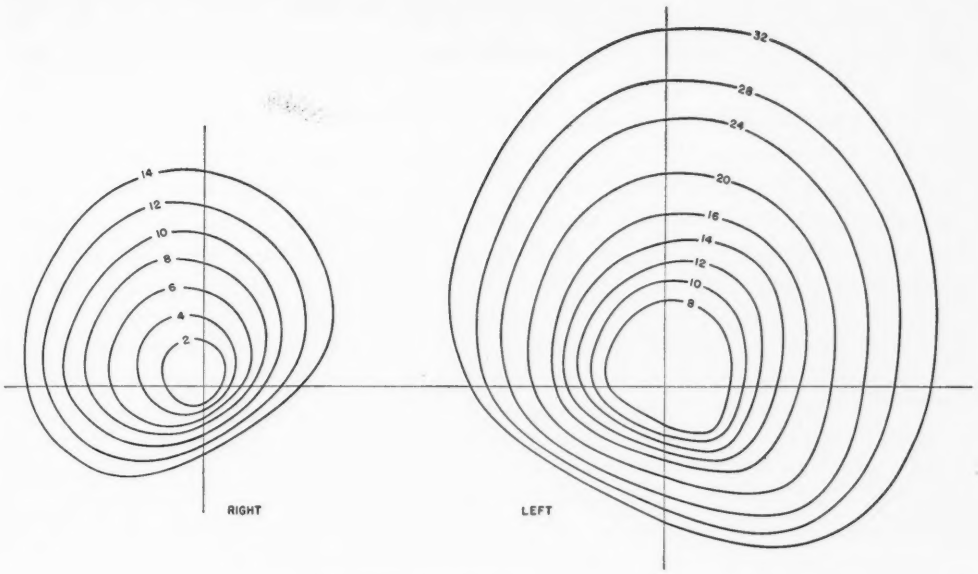


Fig. 16.—The testing assembly secured to a calibrated table with the right abutment tooth placed at the center of rotation. Measurements of tooth movement during application of known loads were required for the preparation of conversion charts.




PRESSURE CALIBRATION
(OUNCES)

Fig. 17.—Charts used to convert direction and distance of tooth movement to pressure required to produce the movement.

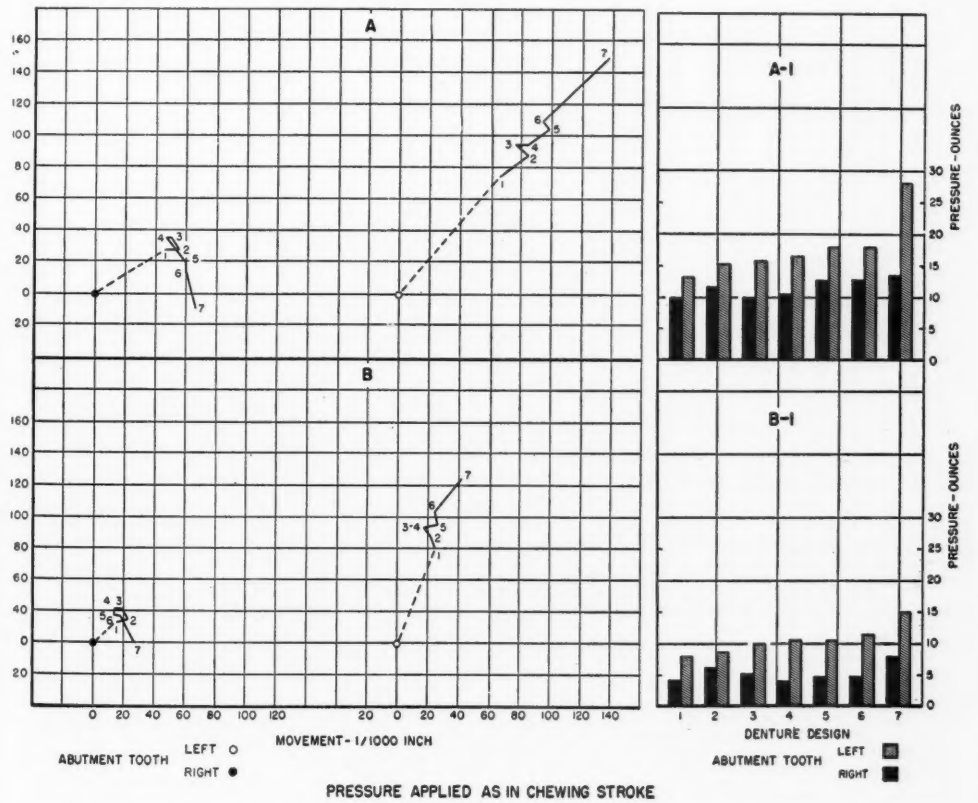



Fig. 18.—*A*, Movement of the magnifying rods throughout the series of design changes, with force being applied to the lower left first molar.

*B*, The same, but with force being applied to the lower left second molar.

*A-1*, Pressure imparted to the abutment teeth when loads were applied to the lower left first molar.

*B-1*, The same, but with loads applied to the lower left second molar.

*Pressure Applied as in Hinge Closure* (Fig. 19).—

1. Both abutment teeth moved posteriorly in the general direction of the force, but somewhat to the right, until various modifications of the denture resulted in marked reduction in movement of the right tooth. The effect of torque or rotation of the appliance about the left tooth was sufficient again to carry the right tooth anterior to its static position.

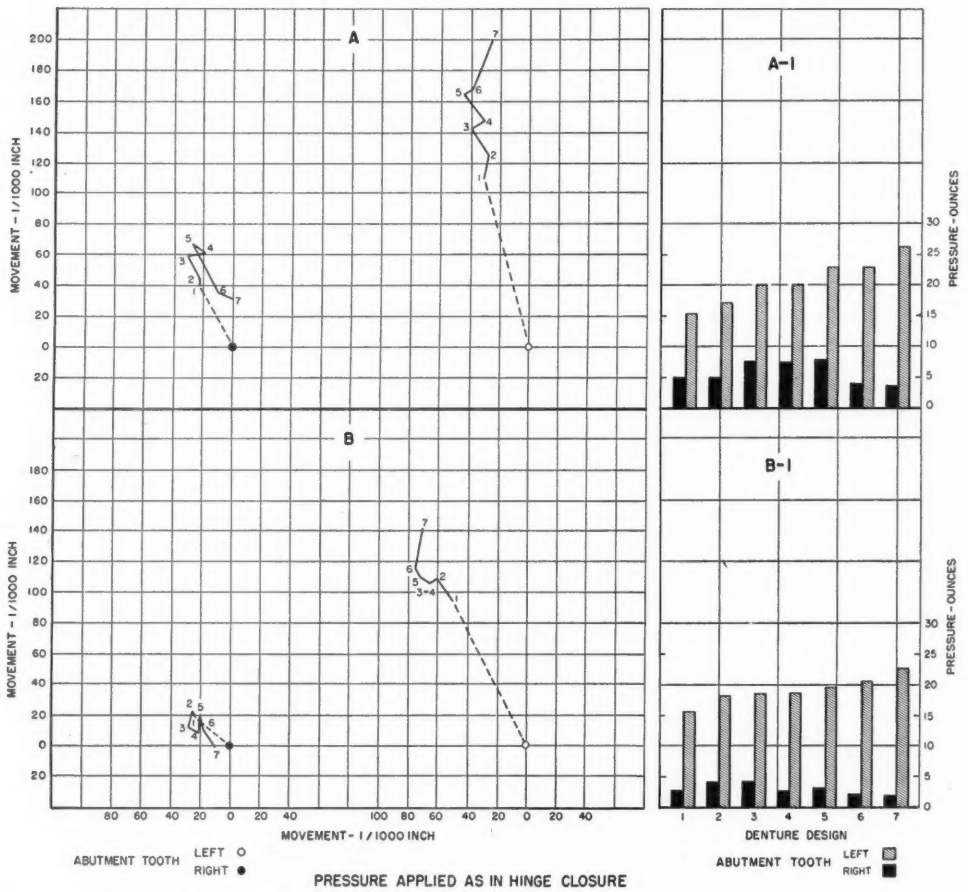



Fig. 19.—*A*, Movement of the magnifying rods throughout the series of design changes, with force being applied to the lower left first molar.

*B*, The same, but with force being applied to the lower left second molar.

*A-1*, Pressure imparted to the abutment teeth when loads were applied to the lower left first molar.

*B-1*, The same, but with loads applied to the lower left second molar.

2. Similar but less movement of the abutment teeth occurred when pressure was applied to the second molar than when applied to the first molar. The reduction in movement was most marked at the right tooth.

3. During loading of the first molar, the greatest increases in movement of the left abutment tooth occurred after the removal of the double rests, after the

removal of the first bicuspid rests, after the removal of the continuous lingual rest, and after the reduction of the size of the denture bases. With the same loading, the greatest increase against the right tooth occurred after the removal of the first bicuspid rests. Movement of the right tooth decreased markedly after the last two modifications were made.

4. During loading of the second molar, the greatest increases in movement occurred after the removal of the double rests and after the reduction of the size of the denture bases. With the same loading, movement of the right tooth decreased following each modification except the removal of the double rests and the removal of the continuous lingual rest.

*Pressure Applied Horizontally From the Lingual Side* (Fig. 20).—

1. Both abutment teeth moved anteriorly to the left in the general direction of the force until changes in design caused posterior movement of the right tooth. Limited effects of torque or rotation of the denture were evident.

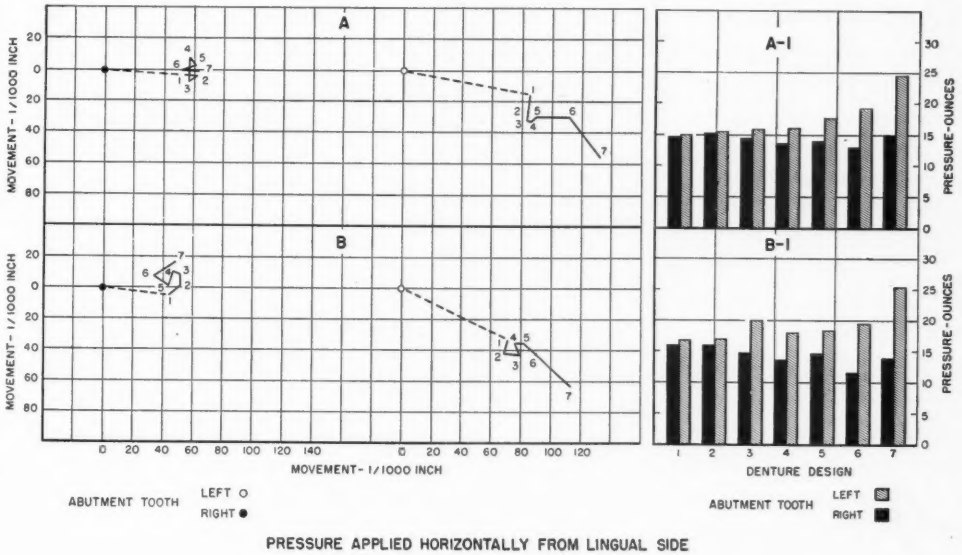



Fig. 20.—*A*, Movement of the magnifying rods throughout the series of design changes, with force being applied to the lower left first molar.

*B*, The same, but with force being applied to the lower left second molar.

*A-1*, Pressure imparted to the abutment teeth when loads were applied to the lower left first molar.

*B-1*, The same, but with loads applied to the lower left second molar.

2. Similar but slightly less movement of the abutment teeth occurred when pressure was applied to the second molar than when applied to the first molar.

3. The greatest increases in movement of the left abutment tooth occurred after the removal of the double rests, after the lingual bar was made flexible, and after the reduction of the saddles.

4. Movement of the right tooth decreased after each modification except the removal of the double rests and the reduction of the saddles. The latter alteration effected a relatively large increase in movement of this tooth.

*Pressure Applied Horizontally From the Buccal Side* (Fig. 21).—

1. The left abutment tooth moved posteriorly to the right in the general direction of the force. At the same time, the right tooth moved anteriorly to the right. Strong evidence of torque or rotation of the denture was seen in the movement of this tooth to a point anterior to its static position.

2. Movements of the abutment teeth were within a smaller range when force was applied to the second molar than when applied to the first molar.

3. The greatest increase in movement of each abutment tooth occurred after the removal of the continuous lingual rest.

4. Movement of the right abutment tooth decreased markedly after modification of the lingual plate and after the lingual bar was made flexible.

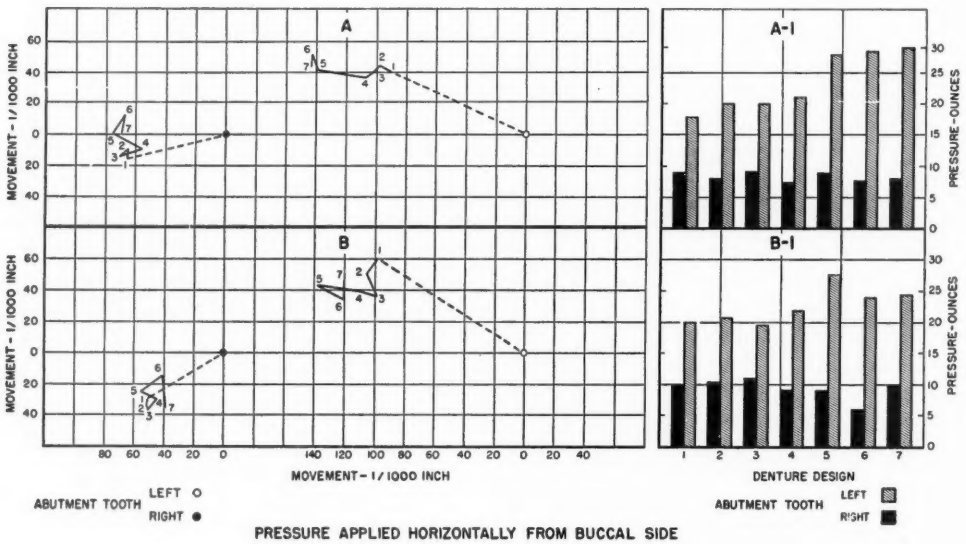



Fig. 21.—*A*, Movement of the magnifying rods throughout the series of design changes, with force being applied to the lower left first molar.

*B*, The same, but with force being applied to the lower left second molar.

*A-1*, Pressure imparted to the abutment teeth when loads were applied to the lower left first molar.

*B-1*, The same, but with loads applied to the lower left second molar.

OBSERVATIONS REGARDING FORCES DELIVERED TO ABUTMENT TEETH

*Pressure Applied as in Chewing Stroke* (Fig. 18).—

1. Considerably more force was imparted to each abutment tooth when pressure was applied to the first molar than when applied to the second molar.

2. When force was applied to the first molar, each modification of the denture resulted in increased pressure being imparted to the left abutment tooth except when the lingual bar was made flexible, and no immediate change was noted. Similar increases occurred upon loading of the second molar except that no change occurred after the removal of the continuous lingual rest.

3. During loading of the first molar, there was a general increase in pressure against the right abutment tooth except after the removal of the first bicuspid rests when a relative decrease occurred. When loading was shifted to the second molar, the pressure at the right tooth increased following the removal of the double rests, modification of the lingual plate, and the reduction of the size of the denture bases.

*Pressure Applied as in Hinge Closure* (Fig. 19).—

1. In general, more force was imparted to each abutment tooth when pressure was applied to the first molar than when applied to the second molar.

2. Each modification of the denture resulted in increased pressure being imparted to the left abutment tooth except modification of the lingual plate and the reduction of the lingual bar when no changes occurred. Similar increases occurred upon loading of the second molar except after modification of the lingual plate when no change occurred.

3. During loading of each of the molars, modifications of the denture effected changes in pressure against the right abutment tooth which did not follow any definite trend. Pressure increased against this tooth following the removal of the continuous lingual rest, however, and decreased following modification of the lingual plate, the reduction of the lingual bar, and the reduction of the size of the denture bases.

*Pressure Applied Horizontally From the Lingual Side* (Fig. 20).—

1. In general, more force was imparted to each abutment tooth when pressure was applied to the second molar than when applied to the first molar.

2. Modifications of the denture effected marked changes in pressure against the left abutment tooth, although relatively minor changes occurred at the right tooth.

3. When force was applied to the first molar, each alteration of the denture resulted in increased pressure at the left abutment tooth. Similar increases occurred upon loading of the second molar, except that a relative decrease in pressure occurred after modification of the lingual plate.

4. Regardless of the point of loading, there was a tendency toward decrease in pressure at the right abutment tooth throughout the series of modifications in design. However, increases occurred following the removal of the double rests, the removal of the continuous lingual rest, and the reduction of the size of the denture bases.

5. Regardless of the molar loaded, the greatest increase in pressure against each abutment tooth occurred after the reduction of the size of the denture bases.

*Pressure Applied Horizontally From the Buccal Side* (Fig. 21).—

1. Loading of the second molar created greater pressure against the abutment teeth than did loading of the first molar with the first, second, and fourth denture designs. With the other design situations, loading of the first molar effected greater movement of the abutment teeth.

2. When force was applied to the first molar, each modification of the denture resulted in increased pressure being imparted to the left abutment tooth except the

removal of the double rests when no change occurred. When loading was shifted to the second molar, the general upward trend persisted except after the removal of the double rests and after the removal of the continuous lingual rest when marked decreases occurred.

3. During loading of the first molar, changes in design effected variations in force against the right abutment tooth which did not follow any definite trend. When loading was shifted to the second molar, there was still no definite trend, but marked decrease in pressure occurred when the lingual bar was made flexible. The pressure increased slightly after the reduction of the size of the denture bases.

## SUMMARY

Because of the lack of research studies, the exact behavior of partial dentures in function has not been determined. Neither has it been learned how much the distribution and dispersal of the force can be influenced by the dentist through modifications in denture design.

The present studies were conducted under laboratory conditions to determine some of the effects of the design of partial dentures on the distribution of forces to the abutment teeth. Although the testing situations were not identical with those existing in the mouth, the results indicate that the loading and movement of the teeth are strongly influenced by such factors as the number and location of rests, contour and rigidity of connectors, and extension of denture bases. Undoubtedly other variable factors, such as functional basing, breaking of stress, and the application of direct and indirect retainers, are equally important for consideration.

Continued investigations are necessary along both physical and biologic lines. They will yield information ultimately for the development of denture designs which are wholly compatible with the physiologic tolerances of the residual oral structures.

I wish to express indebtedness to J. C. Thompson, B.S., F. D. Carpenter, B.S., and W. E. Gilbert, U. S. Navy Electronics Laboratory, San Diego, California, for their counsel and technical assistance in these studies.

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# A PROBLEM OF RETENTION IN A LOWER PARTIAL DENTURE*

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THE REMOVABLE PARTIAL DENTURE is a product of study and analysis. Inadequate deliberation upon the factors present in any given situation may easily result in failure. As most unsuccessful partial dentures result from failures of design, not of materials, a careful plan of design and subsequent construction must be conceived with due consideration for all the problems involved.

## CLINICAL EXAMINATION

The patient, a 57-year-old white woman, was accepted as a clinical patient at the Ohio State University, College of Dentistry, during December, 1954. Her primary complaint, as volunteered, was a general "soreness and loosening" of the teeth. A preliminary examination revealed a relatively high degree of caries resistance, with only one gold inlay indicated as a replacement for a mesio-occlusal-distal cavity with buccal onlays in the upper left second molar. The remainder of her dentition was found to be definitely sound from an operative standpoint.

However, both arches exhibited extensive manifestations of the chief complaint, a disturbance of the periodontium diagnosed as periodontitis. Such indicative symptoms as inflammation of the mucous membrane of the marginal gingivae, recession, pocket formation, and mobility of the teeth were observed in most areas.

The lower arch reflected considerably more extensive damage, definitely necessitating the removal of two mandibular molars which were operatively sound. The periodontium of these teeth exhibited degenerative changes which must be considered irreversible, i.e., periodontal pockets exceeding a depth equal to one-fourth the total root length, the alveolar crest resorbed to a similar depth, and the observation on roentgenograms of rarefactions at the bifurcations of the roots. The occurrence of these conditions positively indicated the removal of the mandibular right second and left first molars.[1] The fate of the remaining teeth of the lower arch—the central incisors to second bicuspids inclusive—depended upon the success of the prescribed periodontal therapy. The proposed abutment teeth for the subsequently diagnosed removable partial denture—the second bicuspids—merited only a fair prognosis. (Figs. 1 and 2).

As the periodontal treatments progressed, the patient developed excellent oral hygiene habits. This cooperation plus a favorable general health picture increased the possibility of fully successful treatment. In conjunction with the relatively low caries susceptibility, a lack of incidence of demineralized areas was apparent. Due to the patient's extreme desire to circumvent the loss of additional teeth, it was

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highly probable that her utmost cooperation in the maintenance of the remaining teeth and their investing tissues would continue.

At the end of periodontal treatment, total elimination of inflammation from the mucosa was noted. The tissues distal to the abutment teeth were firm, and an absence of irregularities indicated a favorable arch form. Neither abnormal form nor alignment of the remaining teeth was evident. Re-establishment of occlusion could be accomplished with comparative ease. But even after careful equilibration of the patient's natural occlusion, a certain degree of mobility could not be eliminated from the proposed abutment teeth. Although these teeth had been improved to a state, according to Miller's[2] classification, of less than a Class II degree of mobility (i.e., less than 1 mm. displacement possible in either direction), they could not be considered sufficiently strong to be utilized as Kennedy[6] Class I partial denture abutments.

Fig. 1.

Fig. 2.

Figs. 1 and 2.—Roentgenograms of the bicuspid areas of the mandible prior to the removal of the involved molar teeth.

## FACTORS INVOLVED

As we wish to supply missing teeth without jeopardizing remaining teeth and supporting structures, any appliance must be considered a failure which does not meet both of these requirements.

The problem would have been comparatively easy to solve in the day of Pierre Fauchard, by merely attaching the appliance to the remaining teeth with wire "drawn from ducat gold."[4] But since one of the main functions of a partial denture is to prevent or control periodontal disease,[3] a question arises as to which of the many and varied methods of retention is indicated for a case in which the abutment teeth are certainly not ideal, but which, because of their soundness and the patient's strong desire for their preservation, are worthy of being retained.

In respect to the conservation of periodontal tissues, Neurohr[5] lists distribution of forces, passivity, and lateral pressures as the primary considerations in the design and construction of partial dentures. With these considerations in mind, the cast was surveyed and found to be reasonably simple from the insertion and retention aspects, with the exception of extremely deep undercuts on the mesiolingual surfaces of both abutment teeth. However, this fact presented no problems in the final analysis and design.

According to the conventional methods of design, the case tended to indicate the use of combination double-bracing, double-retaining type clasps. When the occlusal plane was in a horizontal position, mesiolingual undercuts of the second bicuspids measured slightly less than 0.030" by the Ney classification.[7] In accordance with Applegate's[8] indications for a combination type clasp, two of his five criteria are present—a free-end extension type of partial denture which has yielding tissue support (so considered because these ridges must be placed in a "recent extraction" category), and deep tooth undercuts which prevent use of bar clasps approaching from a cervical direction (such as Roach bar clasps).

Varied opinions have been expressed concerning the effect of denture-bearing stress upon the underlying tissues and upon the periodontium of clasped teeth. Trapozzano[3] and Okun[9] recommend auxiliary measures, such as multiple clasping and splinting via soldered inlays in certain instances where the bone support of abutment teeth is unfavorable for primary clasping. In opposition, Chayes maintains that splinting, as any fixation, is "uncalled for in any situation—with anything which lives and functions." He has demonstrated that material movement of the teeth during mastication is largely responsible for stimulation of blood supply to the surrounding tissues.[10]

Various abnormal stresses are transmitted to the periodontium of clasped teeth. First, since few exhibit parallel convexities, clasp arms are seldom located in the same horizontal plane. Therefore torsion develops. However, this difficulty may be overcome by actually modifying the surfaces of the tooth to be clasped. Second, destructive traction might occur which may be capable of causing injury to supporting tissue during insertion and removal of the prosthesis.[11] Third, when the denture seats itself as ridge resorption occurs, according to Lammie and Osborne,[12] there exists a backward torque on the abutment tooth in a distoinferior direction with premature destruction of the supporting structures *if* the abutment is clasped in the usual manner.

Occlusal rests are valuable assets to the average partial denture design in that they help relieve the soft bearing areas of a large proportion of horizontal and lateral stresses of mastication. But it must be remembered that the abutment teeth considered in this case were at one time scarcely able to bear the stresses placed upon them by simple mastication and their natural antagonists, and although their stability has been greatly restored, they could hardly be expected to bear more than their share of the total burden. Schopper[13] recommends the substitution of auxiliary devices for the preservation of the remaining teeth and the elimination of the occlusal rest per se. However, in contradiction, Glickman[14] discourages attempts to construct partial dentures without lug rests in instances in which a periodontal condition around the remaining teeth does not warrant loads. He contends that the settling of such dentures stimulates pathologic periodontal changes, which are comparatively more harmful than those which might result from the added stimulus of stress upon the teeth. It is written by Jones[15] that prolonged pressure on the saddle-bearing tissue may result in pressure atrophy—as caused by gravity. Jones, therefore, advocates the need for a maximum allowable load on the teeth. In this case, this maximum allowable load offers little which could be considered conducive to a successful restoration.

## THE DESIGN

An evaluation of these afore-mentioned opinions seems to indicate one universal conclusion as described by DeVan[16] when he stated that, in partial denture prosthesis, our objective must be the "perpetual preservation of what remains rather than the meticulous restoration of what is missing." It was with this concept in mind that, after due deliberation of the existing factors and particular attention to the problems of stress as outlined by Friedman,[17] a final treatment plan was devised for this patient.

DeVan[16] states that although spring tension by resilient clasping is the simplest and most positive means of securing retention, it is also the most dangerous method to the welfare of the abutment periodontal membrane. His explanation of this conclusion lies in the increased degree and frequency of periodontal displacement. DeVan supports this concept by suggesting other means of augmenting the use of "clasps," such as the frictional contacting of two or more parallel surfaces and the accurate reproduction of tissue detail in saddles and connectors to induce the forces of adhesion or interfacial surface tension.

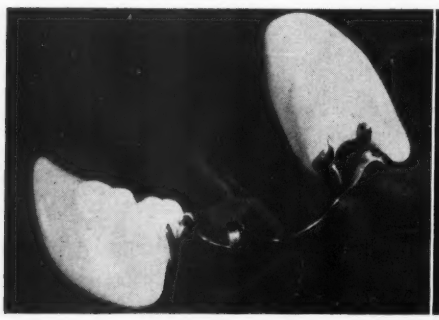

Fig. 3.

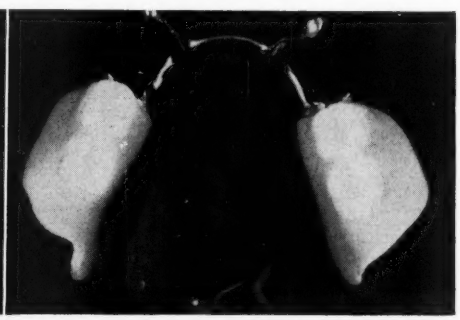

Fig. 4.

Figs. 3 and 4.—The completed denture. Note the lug-type indirect retainers.

The cast was resurveyed to accommodate this type of design, and it was noticed that desirable undercuts of an even depth and regular curvature could be secured on the distolingual and distobuccal surfaces of both abutment teeth. If lugs were to be placed in these existent undercuts on the bicuspids, these structures (see Figs. 3 and 4) would serve the function of indirect retainers in reducing the movement of the denture base away from the subjacent tissue.[18]

Embrasures ideal for the placement of embrasure hooks were present between the cuspids and first bicuspids on both sides. When this structure is included in the framework of the denture, the device actually becomes tooth borne at the abutment end.[19]

Therefore, most of the stresses which will be transmitted to the teeth will be delivered through this embrasure hook to the cuspid and the *combined* strength of the first and second bicuspids. This combination of direct and indirect retainers fulfills required clasp functions, and renders the framework resistant to displacement during mastication. The fourth of Neurohr's[20] "Ten Commandments of a Good Restoration" is that the restoration must offer *complete* resistance to these

forces which tend to displace the denture. The proposed design of this denture will not completely meet the specifications laid down in this "law," because there will be in this instance, as with any other distal extension free-end saddle arrangement, a displacement of the soft tissues underlying the denture base with the application of masticatory load. The effect of this displacement is, as indicated above, a torsion which must be absorbed by the clasped teeth. A distinct advantage to be found in this design is that the weak abutment tooth is relieved of this stress as the lugs actually disengage from all contact with the distal of the abutment teeth when force is created in a direction perpendicular to the occlusal surfaces of the teeth. The prosthesis is not entirely tissue-borne, however, as the embrasure hook answers favorably the prerequisites of a direct retainer. As the fulcrum of displacement moves in an anterior direction from the second bicuspid to the embrasure between the cuspid and the first bicuspid, the angle of displacement decreases, indicating a diminished amount of torsion placed upon the involved clasped teeth (Fig. 5).

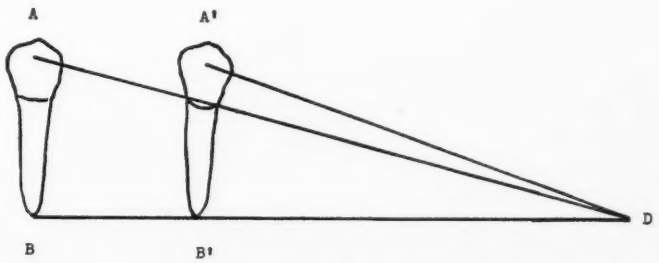


Fig. 5.—The effect upon leverage produced by placing the direct retainer in a position anterior to the abutment tooth. Note the decrease in the degree of angulation ADB when compared to A'DB'. The letter D represents the most inferior point to which the saddle is depressed upon the application of a perpendicular force. AB and A'B' represent the first and second bicuspid teeth. The effect produced simulates and actual lengthening of the saddle.

It has been felt that the bearing areas under a denture receive some favorable stimulation from normal use. This arrangement allows the tissues immediately adjacent to the most posterior remaining teeth to receive a similar degree of stimulation as does the tissue a few millimeters more posterior.

## OPERATIVE PROCEDURES

Procedures standard to this clinic were employed in the construction of the prosthesis. A preliminary impression in an alginate material was made in a stock perforated tray. A cast was poured, and upon this cast was built an individual tray of acrylic resin, with stops on the incisal edges of the anterior teeth and upon the buccal shelves of the mandible. This resultant tray was finished, perforated, and muscle trimmed in the mouth with tracing compound. As an accurate registration of the undercut areas of the abutment teeth was of paramount importance in this case, an alginate material was also employed in securing the final impression. It is felt by McCracken[21] that an impression using a mucostatic type of material fails to assure displacement of soft tissue to register the best supporting form of the ridge (in order to avoid overloading firm areas and to make certain that the

softer areas are made more compact to be better capable of supporting their share of the work load). But this material does make possible an accurate record of the anatomic form and relationship of the remaining teeth of a dental arch as well as the surrounding soft tissues, so that the prosthesis will not exert pressure on these tissues, and that its retentive and stabilizing components may be correctly placed.

The fabrication of the appliance is relatively simple and basically routine. However, several mechanical features do merit mention in this discussion.* Two features of this particular embrasure hook should be noted. First, no preparation was made in the embrasure to accommodate the retainer; only the existing anatomy was utilized. The retainer must be strong. Second, it is essential to the success of the denture that during the final waxup, two or three layers of 0.001 inch (or suitable) tin foil be placed between the posterior surfaces of the undercut lugs and the wax of the saddle to insure the ability of the lug to spring out of the undercut when such a movement is desired. Third, as there is no clasp to prevent food from packing between the most posterior natural tooth and the most anterior surface of the denture, special care must be employed to establish contact between the distal surface of the abutment and the mesial surface of the first artificial tooth, regardless of whatever recontouring may be indicated on the molar tooth (Fig. 6). Accepted laboratory procedures may be followed in the completion of fabrication.

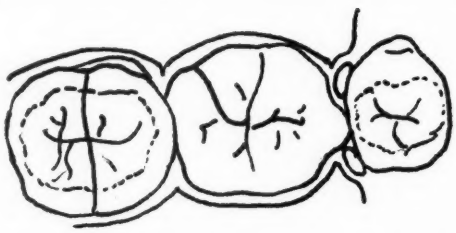

Fig. 6.—The method by which the anterior surface of the saddle is caused to contact the distal surface of the abutment tooth, thus avoiding a space into which food might pack, is illustrated schematically.

## CONCLUSION

The essence of the problem found in this case is the choice of a basic design for the partial denture framework which will utilize and maintain two teeth of somewhat questionable character. The method described was utilized due to its gentleness on these teeth. Conventional clasping would have produced luxation of the weak abutments, while the double clasping arrangement clasps and splints the bicuspids while preventing them from drifting.

The contact accomplished by the members of the framework indeed satisfies the reciprocal action of an ideal clasp if the embrasure hook is continued onto the buccal aspect of the arch and the frictional lugs have been correctly placed into existing undercuts (Fig. 7). Because there is no contact with the weak abutment teeth during vertical load placement, there occurs no danger of inducing torque onto the periodontal membrane of these teeth. The action of masticatory displace-

*The design for this restoration was suggested by Dr. Victor L. Steffel in the course of clinical instruction, and its construction was supervised by Dr. Judson C. Hickey.

ment is not so pronounced to the resulting couplet due to the physical fact that the longer the saddle, the less the *angle* of displacement; and the length of the saddle has, in effect, been increased by situating the direct retainer in a more anterior location.

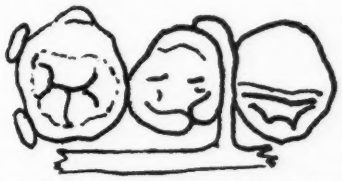

Fig. 7.—The points of contact of the direct and indirect retainers functioning together fulfills the reciprocal action requirement of an ideal clasp.

Fundamentally, the design is sound, and the result has been, to date, most gratifying. The patient has been seen every three weeks since the seating of the appliance, and no change in the effectiveness of the device has been observed. The patient has been advised, however, that, to expect best service from the restoration, periodical prophylaxes and occlusal checkups are essential.

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# THE PHYSIOLOGIC BASIS FOR TOOTH FIXATION IN PRECISION-ATTACHED PARTIAL DENTURES

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ALTHOUGH MOST DENTAL research has been concerned with prevention of caries, statistics reveal that far more teeth are lost through disease of the periodontal structures than through caries.[1,2] A common exciting cause of periodontal disease is the faulty removable partial denture, or fixed partial denture, in which anchorages are improperly selected or incorrectly fabricated.

A physiologic result can be obtained from a dental prosthesis only when the strain exerted on abutment teeth is considered in relation to the biologic union of the tooth to the supporting structures, and the mechanical principles involved.

Biologically, teeth are anchored to alveolar bone by the periodontal membrane, the fibers of which are attached on one end to the cementum of the root, and on the other to the lamina dura.[10,14] In function, groups of fibers limit mesiodistal, buccolingual, and vertical displacement of the teeth. It is generally accepted that the vertical component of force is better tolerated than the horizontal component, since the former is opposed by all of the periodontal fibers, while the latter is resisted by only a portion of the fibers. Under horizontal stress the tooth tends to tip, with the crown and root moving in opposite directions. The fibers toward which the crown and root move are relaxed and offer no resistance to the applied force (Fig. 1). When a force stretches fibers on one side beyond their suspensory capacity, the membrane on the other side may become compressed. If the force, be it vertical or horizontal, is severe or sustained, the membrane may be damaged.

## FACTORS GOVERNING ANCHORAGE OF REMOVABLE AND FIXED RESTORATIONS

With this understanding of biologic and mechanical principles, we can consider three main factors which determine load distribution in fixed and removable partial dentures: (1) occlusal and incisal functional relationships of the remaining teeth; (2) treatment of mobile teeth; (3) methods of anchorage.

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## FUNCTIONAL RELATIONSHIP OF THE TEETH

The most critical phase in the tooth relationships of occlusion is the hinge closure to the centric jaw position. This position is approximated during mastication and attained during deglutition. Teeth which meet prematurely in the centric position will be subjected to excessive stress during function (Fig. 2).[12] This may be particularly pronounced in mutilated arches where the remaining teeth assume the added burden of a prosthesis.

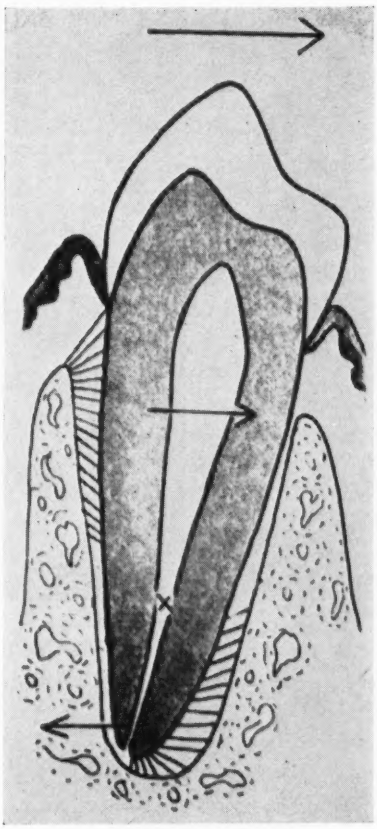
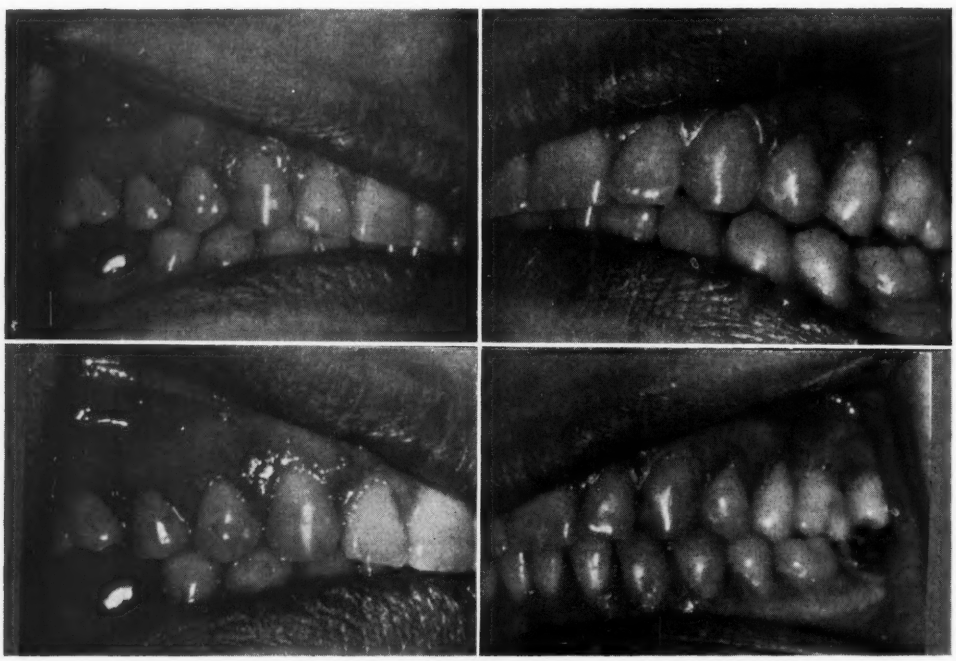


Fig. 1.—A schematic illustration to show that a force applied to the crown of a tooth in a horizontal direction tends to move the lower portion of the root in the opposite direction with corresponding stretching and compression of the peridontal fibers. (From Boyle: Kronfeld's Histopathology of the Teeth and Their Surrounding Structures, courtesy Lea & Febiger.)

To reduce overloading, the relationship of the remaining teeth should be corrected to obtain the optimum distribution of forces in hinge closure and during chewing function. Some selective grinding of the teeth is a preliminary treatment in almost all cases requiring restorative prosthesis.[15] Periodontal factors will determine the extent of modification needed in cuspal angulations and buccolingual diameters, in order to change the direction and distribution of forces on the teeth in centric and eccentric position of the jaws.[5] This treatment is an especially important one when grinding or clamping habits exist.[11]

If extensive selective grinding is needed, dentine will be exposed and sensitivity may occur. In such cases, it may be necessary to consider resurfacing the crowns of the teeth with gold or porcelain to change the occlusal or incisal tooth relationships. Markedly disbalanced dentitions, periodontally involved, will usually need the adjunctive treatment of occluso-rehabilitation.[5]

*A.*



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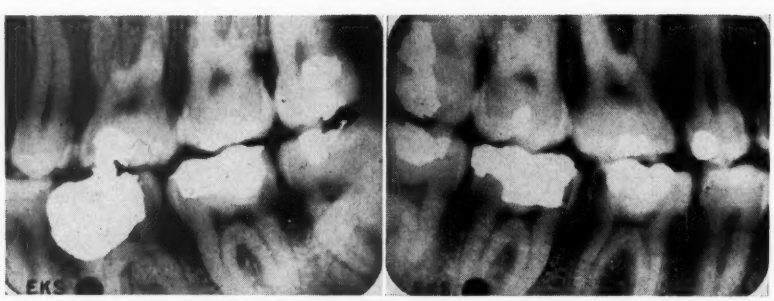


*C.*

Fig. 2.—*A,* Left and right side views showing the tooth relationship at hinge closure of the jaws. The maxillary left first molar and second premolar meet their opposing teeth prematurely. Note the lack of intercuspation of the teeth.

*B,* The static position of tooth closure in the same mouth as dictated by the cusps of the teeth. The mandible has shifted from its hinge position.

*C,* Left and right bite-wing roentgenograms of the same mouth. Note the periodontal bone loss about the maxillary left second premolar and first molar—the area of premature contact. The first molar has an advanced trifurcation involvement. The teeth are mobile and have drifted from proximal contact.

## TREATMENT OF MOBILITY

When a dentition is in functional disbalance, teeth subjected to the resulting stresses may exhibit mobility which may be visible in excursive movements or palpable on tactile examination. Mobile teeth should be considered potentially pathologic, particularly when a dental prosthesis is to be anchored to them. Since the normal is a variable, a certain degree of mobility may be within the physiologic tolerance of the investing tissues.[6] This does not mean that it is always physiologic, nor that it will remain so.

Roentgenographic evidence of a thickened periodontal membrane may indicate excessive vertical or horizontal stress on the tooth which is usually manifested by clinical mobility (Figs. 3, 4). Requiring such a tooth to support artificial teeth may be a factor in exceeding the physiologic tolerance of the investing tissues. Consequently, when teeth are missing, emphasis should be directed to limiting the individual movement of all mobile teeth in the arch, even to the extent of limiting the movement of all remaining teeth.[5,6]

This is especially true if the frequency or duration of stress is increased because of a tapping or clamping habit, particularly if teeth are periodontally affected. Periodontal disease usually implies the presence of loosened teeth; successful periodontal management requires that these teeth be returned to a firmer state. Fixed and removable partial dentures using periodontally affected teeth as abutments may fail unless treatment provides for stabilization of such teeth (Fig. 5).[6]

## METHODS OF ANCHORAGE: RIGID FIXATION

The best means of reducing mobility is by rigid fixation; by splinting tooth to tooth. This treatment is indicated when the amount of bone about the tooth is reduced because of periodontal loss; when morphologic variation of root length or shape results in insufficient anchorage in the bone; or when overloading is a probability. Such splinted tooth units offer greater resistance to leverage on the periodontium which is induced by the functioning dentition, and act particularly as a single unit of resistance to support the stress of removable and fixed dental prostheses. Immobilization permits the repair of periodontal fibers, and the clinical response following periodontal therapy frequently manifests itself roentgenographically by decreased thickness of the periodontal space and reorganization of the supporting bone.

The ideal type of restoration for missing teeth—the fixed partial denture—provides the greatest stability to the abutment teeth. This is an imporant factor in the health of the periodontium. However, Chayes categorically condemned the fixed bridge, because (1) it was unhygienic; (2) he believed that teeth must be permitted to move individually in function, and therefore fixation of abutment teeth was damaging to their supporting structures.

Clinical and biologic evidence does not support this theory. Fixed partial dentures constructed since his time have been vastly improved in design, technique, and construction, and the modern fixed partial denture can be kept as clean as a removable partial denture. As for his second objection, no amount of fixation of teeth can prevent a functional stimulus to the investing structures.[6,7] It is not

necessary for teeth to have individual oscillating motion; the stimulus required for the health of periodontal membrane and alveolar bone is supplied by vertical trusive force occuring during function. This is converted by the oblique fibers of the periodontal membrane into a pull on the alveolar bone.[6,10,14]

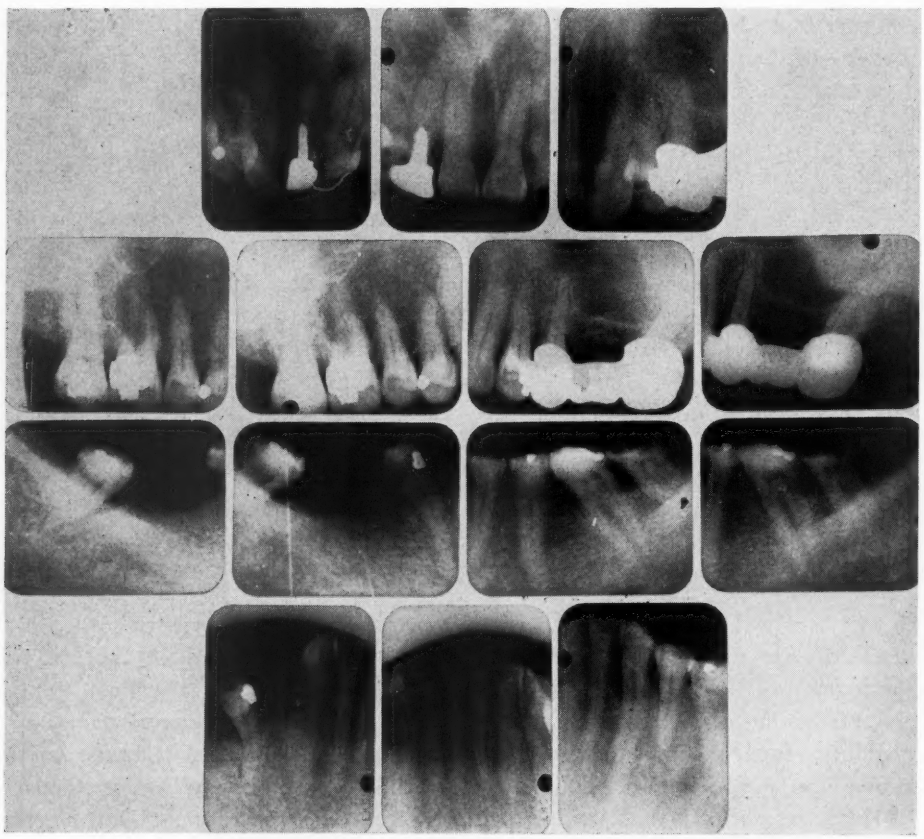


**Fig. 3A.**— *Roentgenograms before treatment.* Note the widened periodontal space about the left maxillary second premolar. Also note the periodontal bone loss about the mandibular left second premolar and the third molars. The patient wears a unilateral clasp removable partial denture.

This theory of the need for individual motion of teeth led to the technique of constructing fixed partial dentures with loose end joints. While it is true that the clinically firm tooth can well sustain this type of construction, a loose and periodontally involved tooth may not (Fig. 6).[5] Moreover, if the tooth relationships of the occlusion are functionally incorrect, there is danger with this type of construction that even a firm abutment tooth may become periodontally impaired because excessive leverage may be exerted on it. While loose end construction *may* provide mesiodistal stability for the tooth, the completely fixed type of construction *does so to a positive degree.*

RIGID FIXATION BY MEANS OF MULTIPLE ABUTMENTS

The usual fixed partial denture is of unilateral construction with single abutments at each end of the restoration. This controls mesiodistal movement, but any buccolingual movement which is present may not be decreased. In these circumstances, additional teeth should be added as abutments to impart buccolingual stability. (See Figs. 3, 4, 5, 6.)

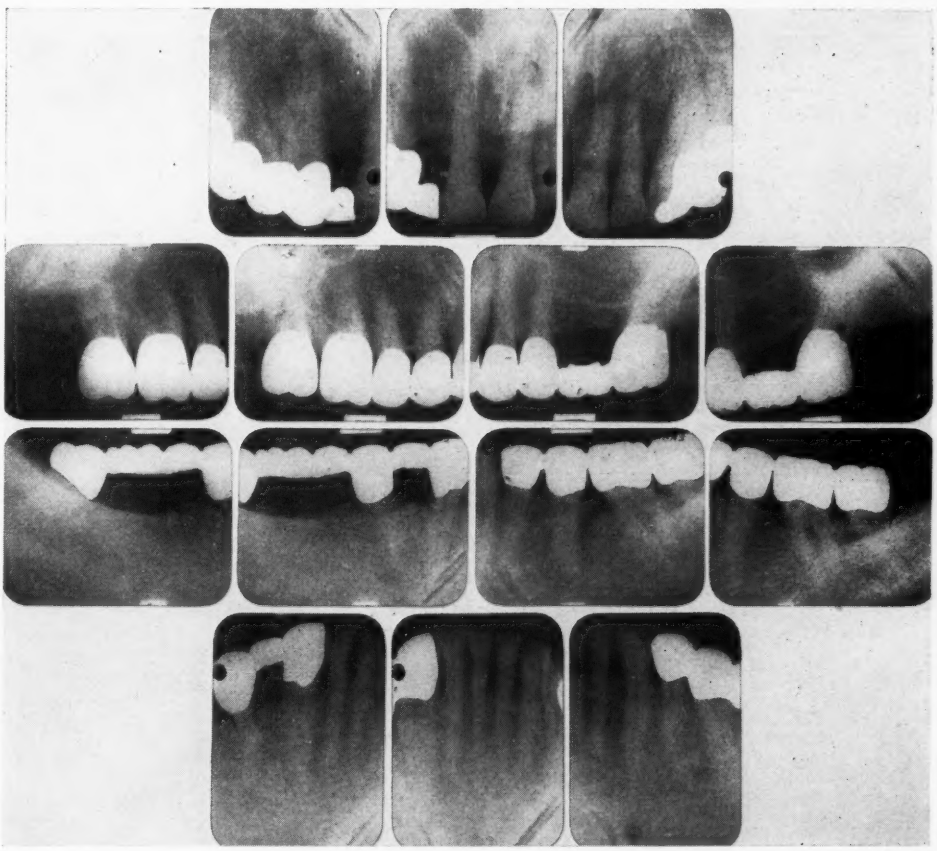


Fig. 3*B*.—*Eleven years after treatment.* The patient was treated by occluso-rehabilitation. Note the roentgenographic evidence of improved height and density of bone about the mandibular left premolar and molar. All missing teeth were replaced with fixed partial dentures. Note the decreased width of the periodontal space about the maxillary left second premolar which is splinted to the first premolar. This example demonstrates the value of fixed prosthesis in rehabilitation of the dentition.

Lack of understanding of the biologic need of buccolingual support for abutment teeth has led to mismanagement in the diagnosis and construction of difficult restorations. It is assumed frequently that when a unilateral fixed partial denture fails to impart needed stability to abutment teeth, the unilateral precision-attachment removable partial denture will provide it. The additional support gained from a denture base resting on soft tissue partly offsets the mobility of the abutment teeth *but does not equal the degree of stabilization benefits to loose teeth provided by a unilateral fixed partial denture with multiple abutments.*

When multiple abutments will not impart buccolingual stability, support must be acquired from teeth across the arch. This is best accomplished by the bilateral fixed partial denture. In many instances, this type of restoration is not prescribed because of reluctance to sacrifice the sound structure of those firm teeth which are required as abutments, or because of their distance from the missing teeth. When suitably distributed abutments are present around the arch, however, missing teeth can be replaced by a continuous fixed partial denture around the arch. The

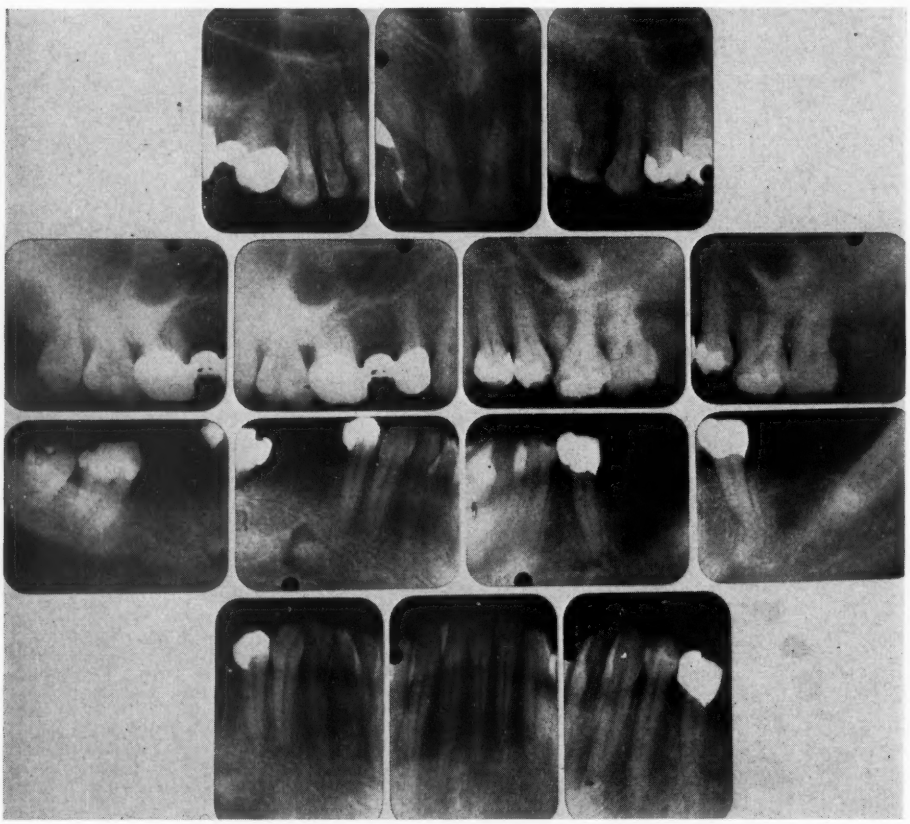


Fig. 4A.—*Roentgenograms before treatment.* Missing mandibular teeth had been replaced with a precision-attachment partial denture which failed to incorporate the proper principles of occluso-rehabilitation. This was evidenced clinically by mobility of the mandibular right second premolar abutment tooth. Note the irregular periodontal space. Also note extruded right maxillary molar teeth and poor proximal contact relationship between the first molar and second premolar. A correct physical arrangement of the natural and artificial teeth is basic to the functional requirement of the partial denture and the periodontal health of the related teeth.

bilateral fixed partial denture serves to stabilize intervening loose teeth capable of being returned to periodontal health. Thus supported, loose teeth then serve as valuable abutments reciprocally with the firm teeth. This demonstrates the clinical value of this principle of fixation (Fig. 7).

The fixed partial denture, however, cannot be prescribed indiscriminately for replacing all missing teeth. When the leverage exerted by the prosthesis during

function exceeds the biologic tolerance of the periodontal structures, overloading of abutment teeth occurs and failure may result.

Fixed partial denture construction is also generally contraindicated when terminal abutment teeth are not firm, and cannot be returned to acceptable firmness. In the case of a bilateral fixed partial denture, both terminal abutment teeth must be sufficiently firm to assure buccolingual stability.

**Fig. 4*B*.—*Roentgenograms fourteen years after treatment.*** Note the use of splinted abutments and a corrected line of occlusion in the right maxillary molar region. The improved periodontal status of the mandibular right second premolar is evident. This example illustrates the value of fixed splinting combined with a removable precision-attachment partial denture.

Prior to preparing teeth for abutments, treatment should consist of selectively grinding the terminal mobile teeth to give them temporary rest from any occlusal contact. After a period of time, which varies with each situation, the teeth should be balanced to both the nonfunctional and functional positions. Even if this treatment fails to effect a marked decrease in buccolingual mobility, these teeth, as well as others required, should be prepared for full crowns and a temporary fixed partial denture of methyl-methacrylate resin constructed. Despite the temporary nature of this replacement, it is imperative that the bridge be placed in functionally correct occlusal or incisal relationships. This temporary restoration will then serve

both to protect the operatively prepared teeth, and to test, by splinting, whether they will become more stable.[5] The temporary restoration should be placed under prophylactic supervision to forestall the possibility of the questionable teeth becoming looser. If the teeth fail to return to acceptable firmness, a removable partial denture is indicated.

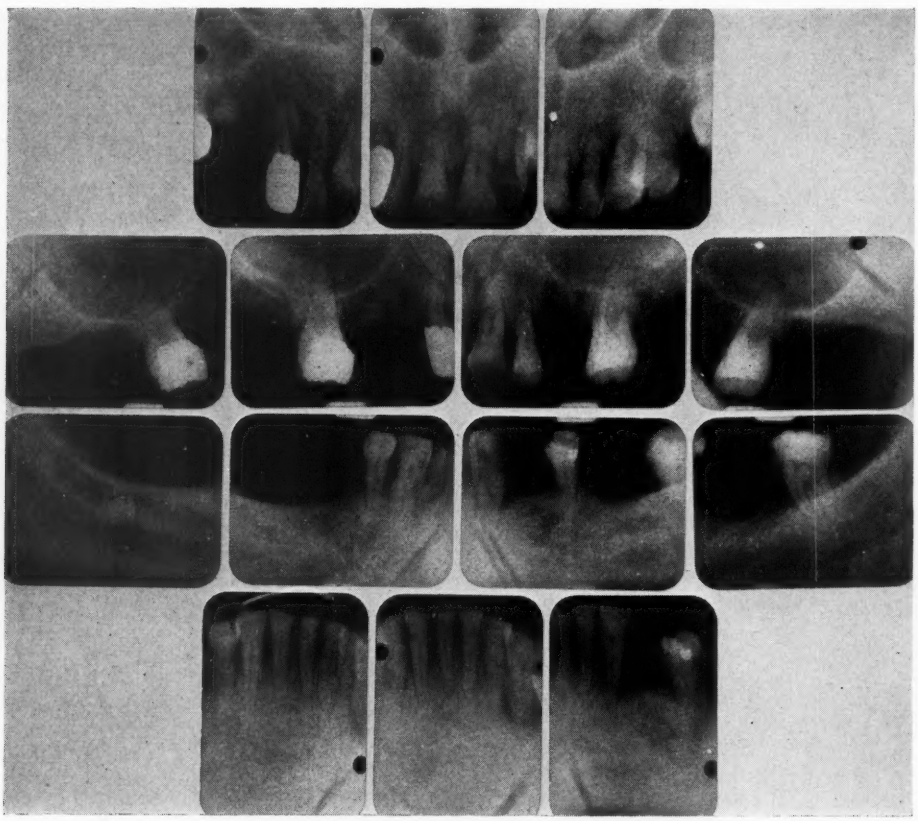


Fig. 5*A*.—*Roentgenograms before treatment.* The patient wore clasp partial dentures and had a tooth grinding habit. Note the advanced periodontal bone loss and attritional wear of the teeth.

## REMOVABLE PARTIAL DENTURES

A precise set of rules cannot be drawn defining when a fixed or a removable partial denture should be prescribed. Frequently both types of restorations may be needed in one arch. When the removable partial denture is indicated, it should not include teeth best restored by fixed replacements and, where necessary, it should include the use of splinted abutments for the removable restoration (Fig. 8).

The removable partial denture here recommended is always bilateral. It is constructed with a *rigid* bar to supply reciprocal support of one abutment across the arch to other abutments. Its use is based on the value of the denture base as a means of transmitting the main burden of the functional forces to edentulous ridge

areas, thus helping to reduce loading thrusts to the abutment teeth. In turn, teeth used as abutments should limit the load to the tissues.

In general, this type of removable partial denture is indicated where: (1) one or more molar terminal teeth are missing; (2) bilateral support is needed for weakened molar terminal teeth; (3) soft-tissue contact over long spans may help relieve overloading of abutment teeth.

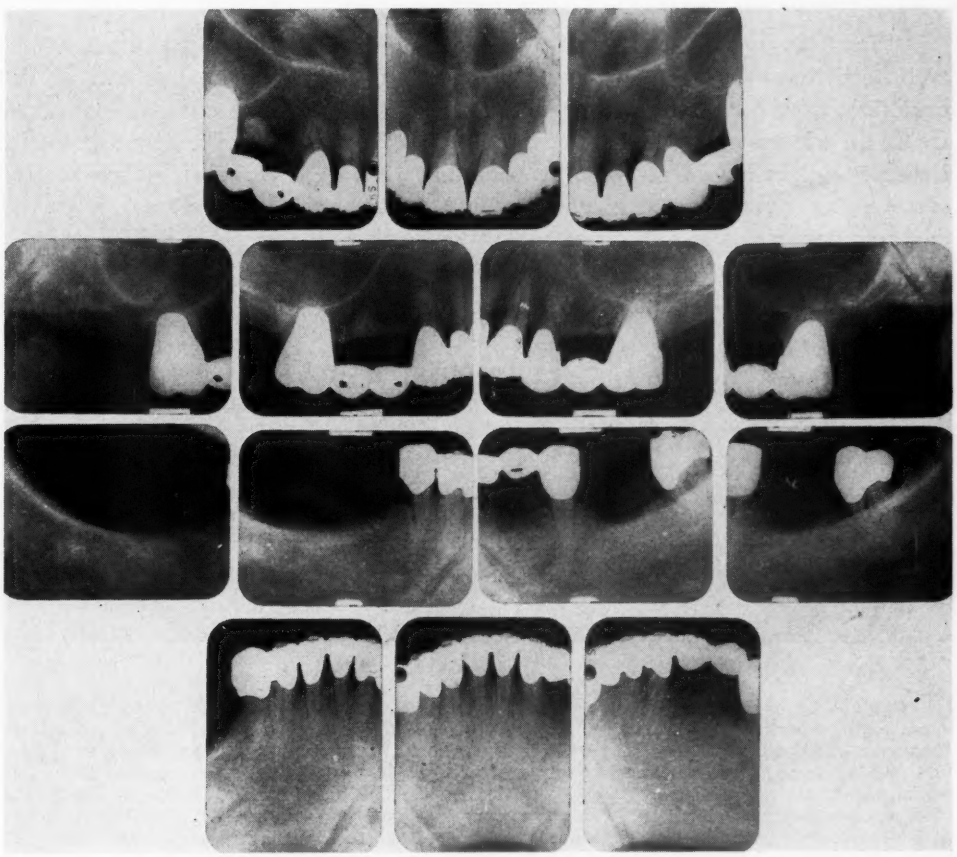


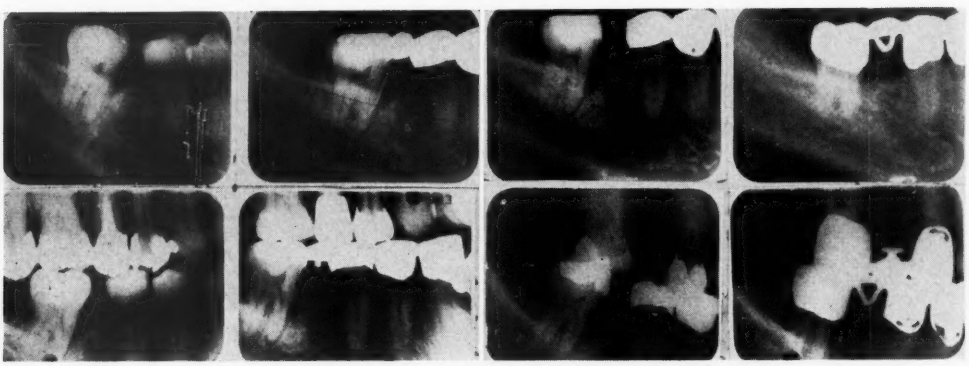
Fig. 5*B*.—*Roentgenograms eight years after treatment.* Note the improved bone height and density. A bilateral fixed partial denture was used on the maxillae. A combined removable precision partial denture and fixed partial denture was used as the mandibular restoration. All missing teeth anterior to the partial denture abutments are included in the fixed restoration.

To assure a physiologic response, the removable partial denture should be designed and constructed so that it: (1) resists vertical displacement; (2) resists horizontal displacement; (3) stabilizes all loose abutment teeth buccolingually and mesiodistally; (4) replaces missing teeth in harmony with the natural dentition and in conformity with mandibular function; (5) conforms to associated structures without irritating tissues adjacent to abutments and under the prosthesis; (6) will not predispose abutment teeth to caries; (7) provides esthetically acceptable means of anchorage to the teeth; (8) permits easy insertion and removal; (9) will not displace teeth or harm teeth or tissues during removal; (10) permits repair with ease.

There are two main types of removable partial dentures: one in which the teeth are left in their natural state and clasp anchorages of various types and designs are used; and the other, in which teeth planned as abutments are operatively prepared to receive cast-gold restorations. These restorations include provision either for an occlusal or incisal rest with clasp retention, or for an intracoronal type of precision attachment.

## CLASP ANCHORAGE

When the normal arrangement of teeth is viewed from the lingual across the arch, teeth used for abutments generally present a lingual undercut area in the mandible; and, conversely, a buccal undercut area in the maxillae. Since teeth facing the edentulous space are also tipped, a further mesiodistal undercut prevails. Because tooth arrangements are often abnormal when teeth are missing, these undercuts are exaggerated, and the construction and use of clasp-type removable partial dentures pose a problem of insertion into and removal from these undercuts.



*A.* *B.* *C.* *D.*

Fig. 6.—An example depicting the need for rigid fixation when a posterior terminal abutment tooth is periodontally involved. *A, Original condition:* Note the bone loss in relation to the mandibular molar. Following periodontal treatment, a fixed bridge was inserted to restore the missing tooth. It was anchored rigidly to the posterior tooth but was attached anteriorly by means of a precision rest. Despite the corrected occlusion and accuracy of the fit of the rest, buccolingual movement in function was not adequately restricted. *B, Three years later:* The periodontal condition was aggravated as a result of the improperly connected bridge. *C,* The bridge was removed. Periodontal treatment for the mandibular terminal molar was reinstituted and a new fixed bridge was inserted, rigidly connected to both the anterior and posterior abutment teeth. (The maxillary premolar was removed because of a root fracture.) *D, Six years later:* Note improvement in the bone height. (From Glickman[5] [chap. 59 by the present author]).

In view of the total tooth positions involved, any combination of clasps used must spring over tooth contours and engage undercut areas for retention, despite surveying and engineering. Most clasps, therefore, place the tooth under tension which the periodontal membrane must resist. This stress is present at all times, even when the teeth are not used for mastication. Thus, portions of the periodontal membrane are under constant compression while the prosthesis is in the mouth. This is not conducive to the health of this highly vascular and sensitive structure.

Lingual and buccal arms of clasps on abutment teeth must be adjusted to strike a balance between imparting stability to the partial denture base and protecting

the teeth against all the reactions to horizontal and vertical force. The clasps, cast or wrought, are of neither exact contour nor fit, and the resultant inequalities exert torque on the teeth. The most careful laboratory procedure may not produce clasps so accurately adapted to the teeth that further refinement at the chair is unnecessary.

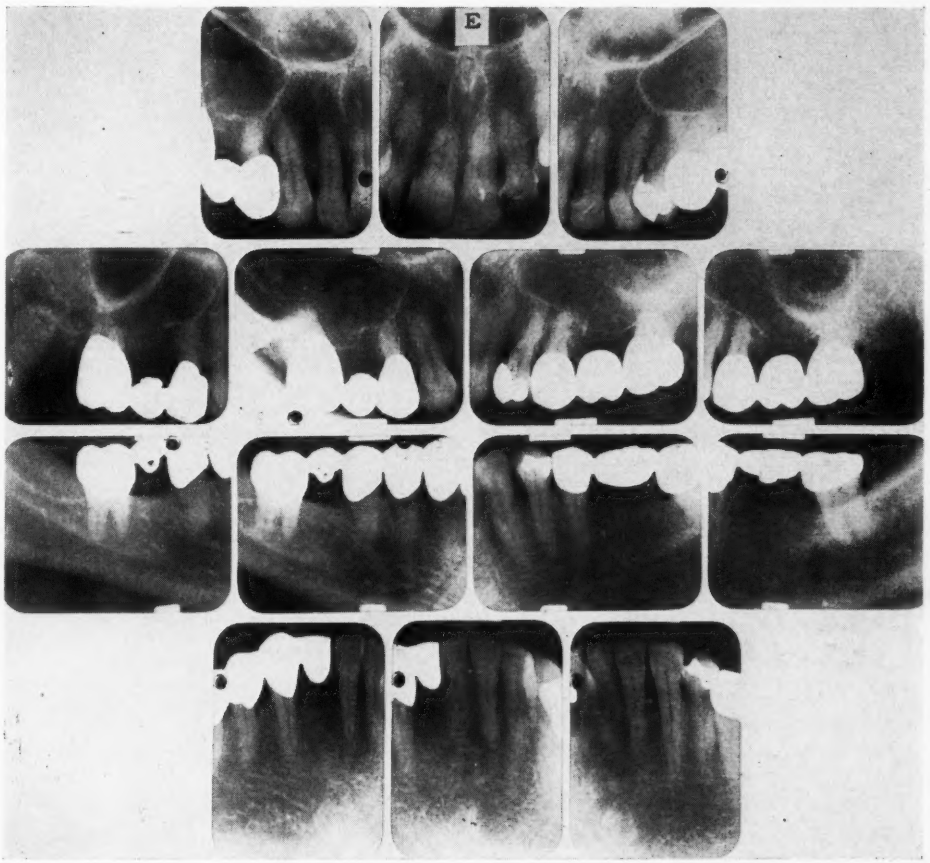



Fig. 6*E*.—*Roentgenograms of the same patient fourteen years after those in Fig. 6A.* Note roentgenographic evidence of continued health of the periodontal structures. The maxillary and mandibular right fixed partial dentures, inserted when the patient was first treated, were constructed by rigid fixation. A controlled clinical situation resulted, illustrating the response to differing types of fixed partial denture construction.

Shiny spots may appear on the internal portion of the clasps after the partial denture has been in use for a short time. This indicates hard bearing areas which may be due to inaccuracies of fit of the clasp or to friction on insertion and removal of the partial denture. In addition, the inner surfaces of clasps are difficult to clean, and as a rule will retain some detritis and bacteria; this, together with possible injury to the enamel caused by the friction of clasps, can be damaging to the natural crown of the tooth.

It is generally accepted that clasps should be provided with occlusal or incisal rests to prevent the partial denture base from moving gingivally and settling into the tissues. While the usual type of rest affords some resistance to vertical stress,

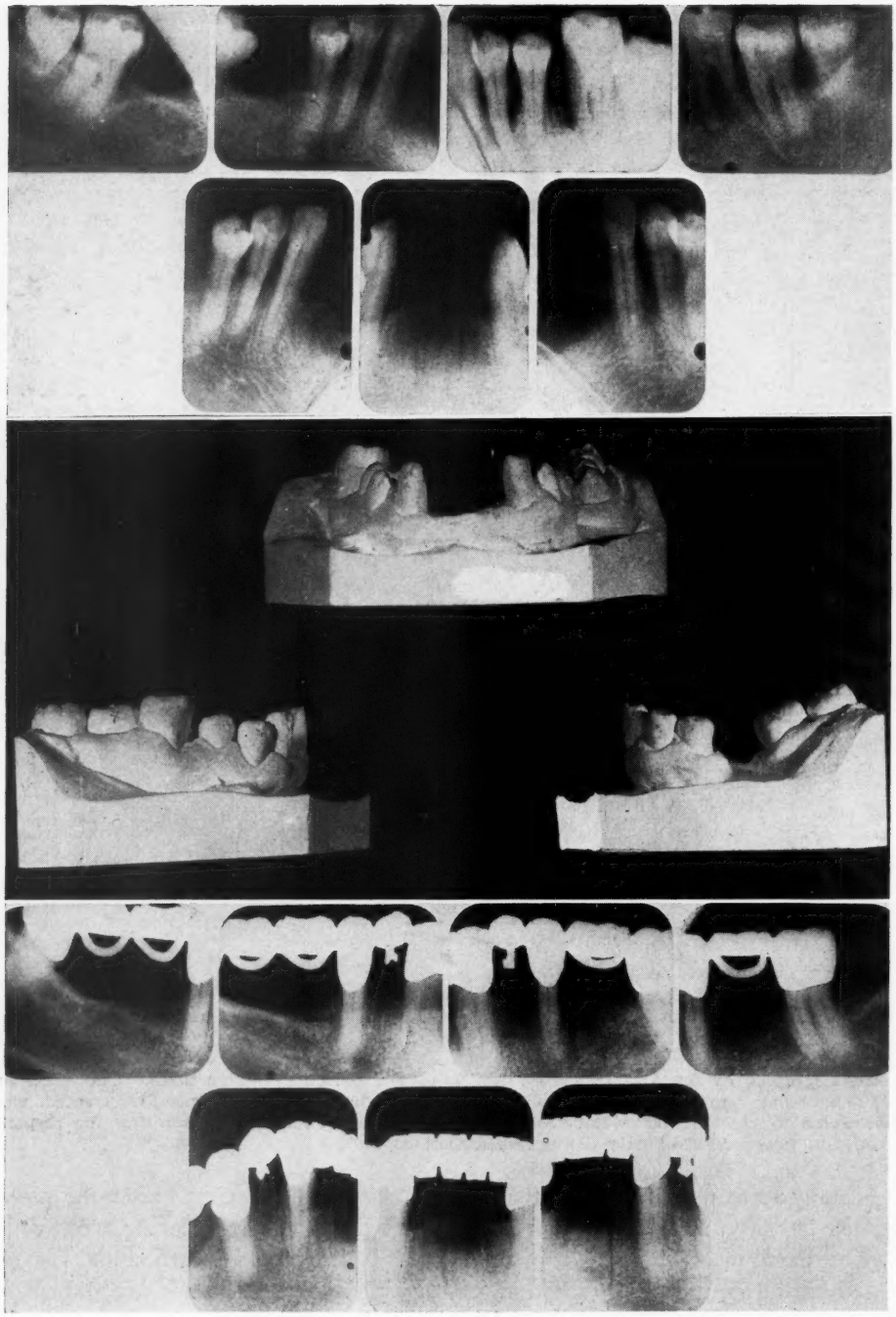


Fig. 7.—Above, *Roentgenograms and casts of a patient's mandibular teeth before treatment.* The patient wore an unsatisfactory mandibular clasp partial denture and a maxillary complete denture. Note the periodontal bone loss and the irregular line of the occlusion of the mandibular teeth.

Below, *Roentgenograms eight years after treatment.* All hopeless periodontally involved teeth, as well as those out of line, were removed. This facilitated the management of the periodontal situation and construction of the complete denture. Mandibular teeth were replaced by a bilateral fixed partial denture. Note improvement of bone height and density.

it is unable to provide resistance to horizontal stress. As the rest is high on the tooth, horizontal functional forces transmitted to it by the removable partial denture tend to tip the tooth.

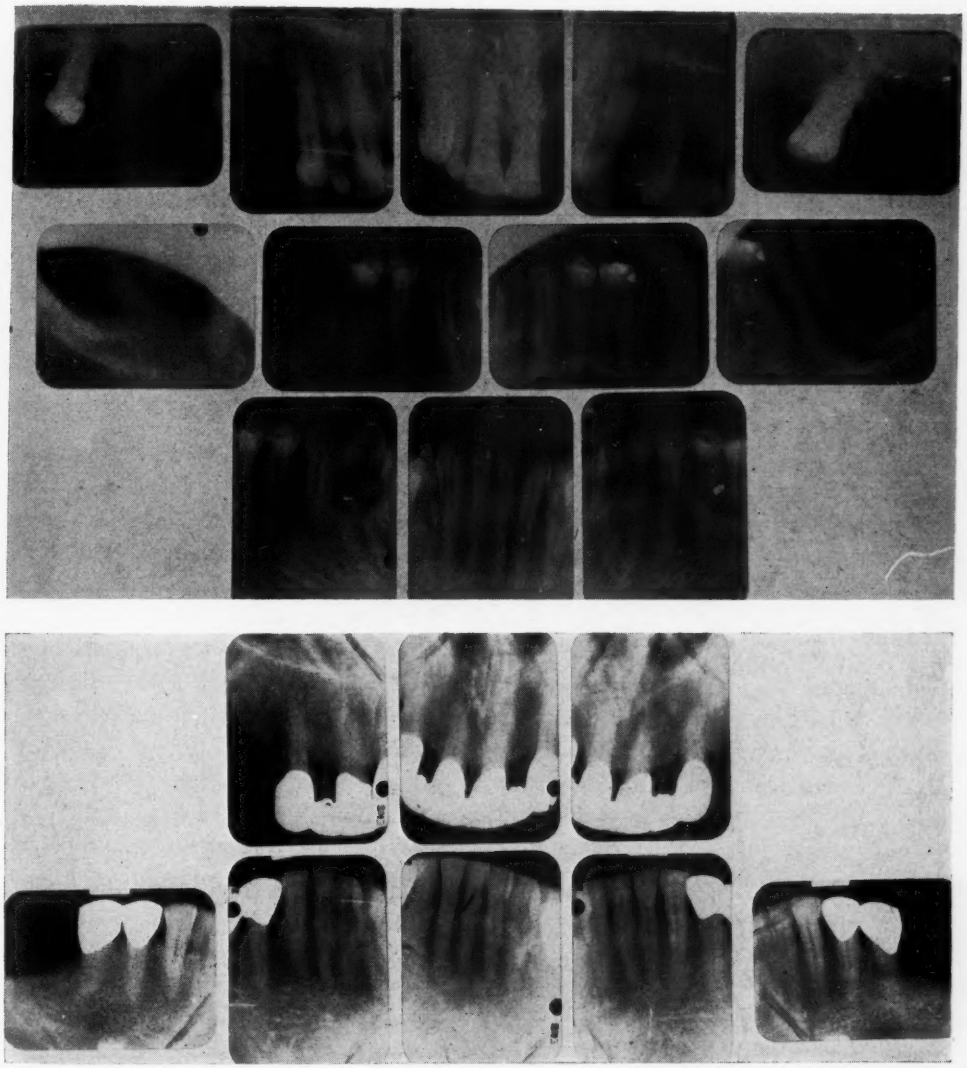


Fig. 8.—Above, *Roentgenograms before treatment.* The maxillary molars were out of line, periodontally involved and mobile. The maxillary left lateral incisor pulp was exposed. These teeth were removed.

Below, *Roentgenograms ten years after treatment.* Treatment consisted of installing bilateral free-end removable precision-attachment partial dentures. Bases were constructed from impressions without tissue displacement and were related in the mouth to the abutment castings.[4] Despite the short span on the mandibular restoration, stress breakers were not required. Note the use of splinted abutments for the mandibular restoration. Also note that the maxillary lateral incisors were not included on the removable precision attachment partial denture. The construction of a fixed partial denture from maxillary left to the maxillary right canine simplified the restorative plan. Note the roentgenographic evidence of maintained height and density of the bone and the normal periodontal space.

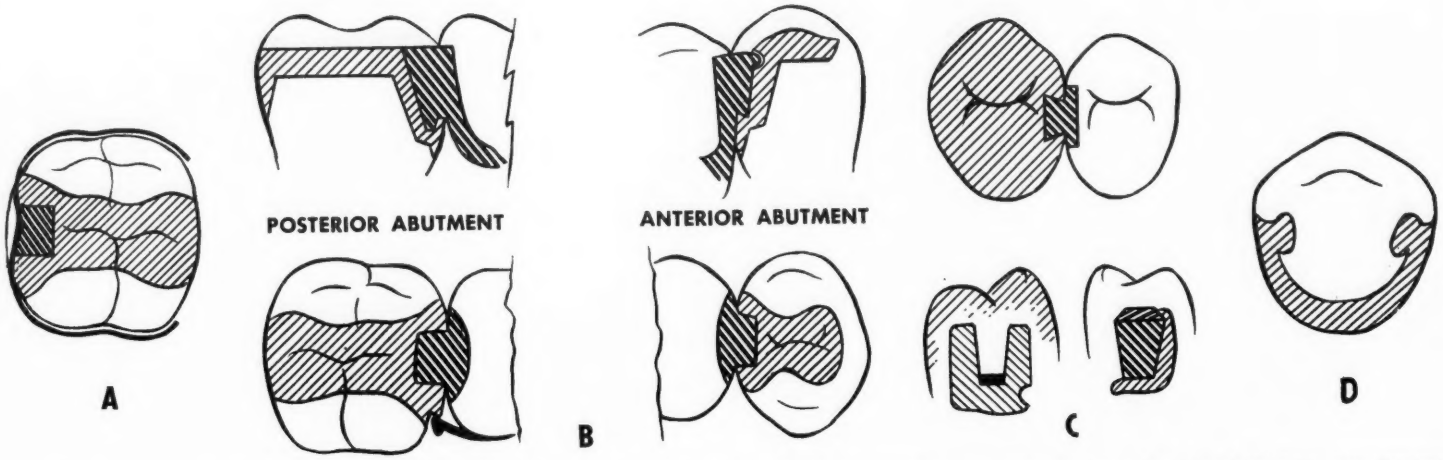



Fig. 9.—*A*, A schematic drawing to illustrate the Gillette clasp. *B*, A schematic drawing to illustrate the principle of Neuhror attachment. *C*, A schematic drawing of the Sherer spring lock insertion attachment. *D*, A schedatic drawing of the three-quarter inset clasp.

## CLASP-TYPE ATTACHMENTS

Modified clasp anchorages have been used successfully: the Gillette,[9] the Neurohr spring-lock insertion,[13] the Sherer spring-lock[16] and the three-quarter cast lingual-inset clasp (Fig. 9). These methods of anchorage approach in function the precision attachment. They all require preparation of abutment teeth to receive a cast-gold restoration which varies from the simple two-surface inlay or three-quarter crown to full crown coverage of the tooth.

*All* of these types of attachments were designed to substitute for the intracoronal precision attachment in removable partial denture construction. The Gillette type of clasp and rest was recommended because it avoided excessive cutting of sound tooth structure. This was necessary years ago when all precision attachments made were too large. The precision attachments available today, however, require far less tooth cutting; their smaller size permits conservative treatment of sound tooth structure.

The Gillette type of anchorage (Fig. 9,*A*) depends on its vertical rest for vertical and horizontal resistance, but it needs a circumferential clasp for retention. The vertical cut-out is not easy to construct; the rest proper is made by forming a pattern into the recess and casting it. Even with exacting fabrication, this cast rest is subject to wear; the only means of retaining the removable partial denture, once this happens, is to adjust the clasp arms. On divergent teeth, there is no assurance that both arms are in equal tension, and, since the pressure is extracoronal, it may exert some stress on the teeth.

Another difficulty with this anchorage is the delicacy of soldering the thin wire clasp. The vulnerable part of the clasp lies at its occlusal portion. Here, soldering often causes the clasp to become brittle; and even when it is soldered correctly, normal use and wear may break part of the clasp in this area. Half a clasp may retain the appliance; but it may also act as a finger spring, inducing displacement of the tooth and possibly damaging the tooth periodontally.

The Neurohr spring-lock insertion-clasp attachment (Fig. 9,*B*) was made to overcome the defects of the Gillette clasp, and also to obviate supposed difficulties in paralleling precision attachments. The Neurohr method employs tapered vertical rests retained within the tooth contours. A single buccal clasp arm engages an undercut in the abutment casting and locks the partial denture in place. Once the partial denture is seated, stress is transmitted to the tooth vertically during function, fulfilling the fundamental requirements for the best reception of force by the periodontium. The path of insertion and removal is an arc compatible with the tapered vertical rests. In some bilateral restorative situations, however, divergent tooth positions may make the path of insertion and removal so cumbersome and difficult for the patient as to contraindicate the use of this retainer.

The Sherer type of attachment (Fig. 9,*C*) also uses a tapered vertical rest. Retention here is provided by an external "L" shaped flat clasp spring arm soldered close to the vertical male rest. This is intended to overcome disadvantages of the Gillette and Neurohr types of retention and is of particular aid where a short abutment is used. When free-end removable partial dentures are used, adjustment of the "L" shaped clasp may disturb the relationship of the denture base to the abutment teeth.

The three-quarter lingual-inset clasp (Fig. 9,*D*) is another attachment that is indicated particularly for use on short teeth. It is, however, not only difficult to construct, but (in order to be used advantageously) it often requires radical preparation of the lingual tooth contours. Frequently this is impossible because of the tipped tooth positions. When successfully employed, the end result is not superior to that of the precision attachment, yet more time must be spent in its construction. It is also frequently fragile, and it cannot be adjusted. (There is very little need to use a short retainer in an abutment tooth. The management of a short abutment is discussed later.)

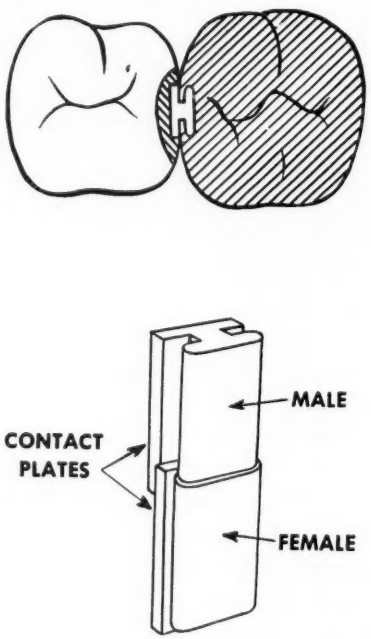



Fig. 10.—A schematic illustration of a typical intracoronal precision attachment.

## PREFABRICATED INTRACORONAL PRECISION ATTACHMENTS

None of these alternate methods of construction accomplishes the degree of tooth fixation or splinting effect on mobile teeth provided by the precision attachment. None of them requires an inflexible path of insertion and removal. The very fact that the path of insertion and removal is not in a fixed line may permit one or more teeth to be subject to excessive stress. The modern precision attachment (Fig. 10), with its apposing contact plates and minimal tolerance of fitted parts, is meant *to fix the teeth between their extremes and to prevent the abutment teeth from moving.*

The intracoronal precision attachment is essentially a prefabricated vertical rest with a flat seat and perpendicular walls. Since it is manufactured to very close tolerances, it is interchangeable. This type of rest consists of two portions:

female and male. The female portion is a housing with a flat contact plate. The male portion consists of a vertical head and a contact plate. The female portion is soldered into the cast-gold restoration of the abutment tooth, and its contact plate then becomes the finished surface against which the male contact plate rests. The head of the male portion, which fits into the female housing, is usually a split bar which can be expanded to compensate for wear or to provide added resistance to displacement. Other designs of precision attachments use replaceable tension springs for this purpose.

The operative and laboratory procedures required for precision-attachment removable partial denture construction are subject to a definite set of rules, well within the technical abilities of any dentist. They are no more difficult and entail no greater skill than other careful dental procedures.

The value of precision attachments lies in the fact that each abutment tooth houses a vertical inset rest, parallel to other such rests needed for the removable partial denture prosthesis. Usually, each precision attachment is placed within the normal anatomic contour of the tooth. Thus, each abutment tooth is restored to normal form and related by parallelism to all the other abutment teeth. The bottom of the female portion of a precision attachment is a flat seat. When functional forces press the vertical head of the male portion of the attachment against this seat, the tooth receives a vertical intrusive force. Since vertical force is best tolerated by the tooth, the entire tooth suspensory mechanism resists the force, and the most tolerant reaction obtains. When this vertical pressure is released, the entire male portion naturally is released from contact with the seat, and therefore rests passively within the housing. Since there is no circumferential pressure, the supporting structure of the tooth is not under constant stress. In contradistinction to most clasps, the teeth are in stress only when functional force is applied.

The parallelism of precision attachments combined with a rigid connecting bar insures the maintenance of the original positions of the abutment teeth. When a precision-attachment removable partial denture is tried in the mouth, the smallest error of positional relationship can be detected and must be corrected.

The insertion and removal of a precision-attachment removable partial denture are limited to one exacting path. This path and the parallelism of the retainers insure that minimum force is needed to insert or remove the denture. Therefore, no strain will be placed on abutment teeth. The teeth are splinted and held in place. Loose teeth become firmer, and often bone support becomes improved with such supportive measures. The important consideration is that teeth with weakened investing structures gain support from other teeth with stronger supporting structures.

Loosening of precision attachments through wear cannot always be prevented; that is the reason provision is made for expanding the head of the male portion of the attachment. Precision attachments can be opened only to the extent of the limitation imposed by the female portion of the attachment. The aggregate of such openings on all precision attachments related to the partial denture base will not change the functional relationship. If a precision attachment is opened in excess, the removable partial denture will not go into place.

## MANAGEMENT OF THE SHORT ABUTMENT

Lateral support for the partial denture is obtained by the length of the precision attachments within the teeth, and by the removable partial denture base connecting all the parallel precision attachments. Whenever possible, the full length of a precision attachment should be used;[17] it is an inflexible rule that *no less than two-thirds of the supplied length must be used.* For this reason, the short abutment tooth has always presented a problem in construction of a precision-attachment prosthesis. Because of the lack of retention of the partial denture, and lack of resistance to displacement forces when the abutment is short, the retainers described previously have often been substituted for precision attachments.

The short abutment problem can be overcome either by gingivectomy or by minimal residual bone reduction of the edentulous areas next to the abutment teeth. Examination of these regions will usually disclose the presence of either an exaggerated gingival crevice or a periodontal pocket. Even when conditions appear normal clinically, edentulous tissues adjacent to proposed abutments will usually disclose thick submucosal tissue, which, when excised, will increase the size of the clinical crown and provide adequate length for the precision attachments. Even when tissues are normal, a judicious amount of alveolar bone should be removed surgically to obtain greater length of clinical crown for the precision attachment (Fig. 11).

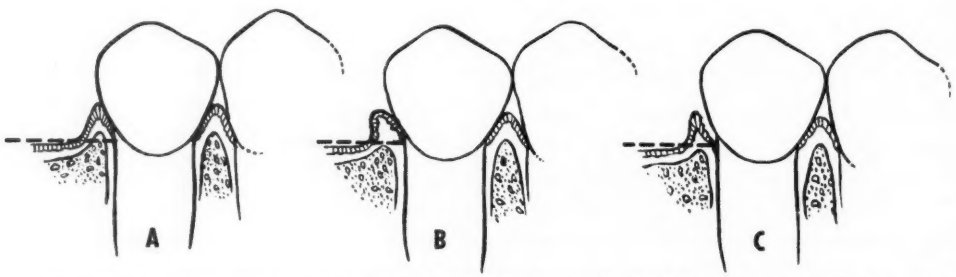



Fig. 11.—A schematic drawing to illustrate the increase of clinical crown length. *A,* Removal of edentulous tissue and alveolar bone crest. *B,* Removal of excessive soft tissue. *C,* Reduction of the pocket by gingivectomy.

To determine how far gingivally a tooth can be prepared to accommodate the proposed length of the precision attachment, an attachment is waxed into the partially prepared tooth with tooth counter wax. A bite-wing roentgenogram is made to measure accurately the amount of space available, and to determine whether further tooth cutting will be safe.

## FORCES ACTING ON THE PRECISION ATTACHMENT

Best results are obtained when all of the precision attachments used are of equal length. Where this is impossible, pairs of precision attachments on similarly functioning teeth, either anterior or posterior, should be of equal length, neither pair violating the length limitation previously mentioned (no less than two-thirds of the supplied length).

Horizontal functional forces from the bolus of food act upon the artificial teeth of the removable partial denture, and tend to cause horizontal tipping of the base, as well as tipping of the male portions within the female portions of the attachments. There are different axes of rotation for the tooth, the precision attachment, and the removable partial denture base. The length of the precision attachment in the tooth influences the axis of rotation of the precision attachment and partial denture: the shorter the attachment, the nearer to the occlusal surface this

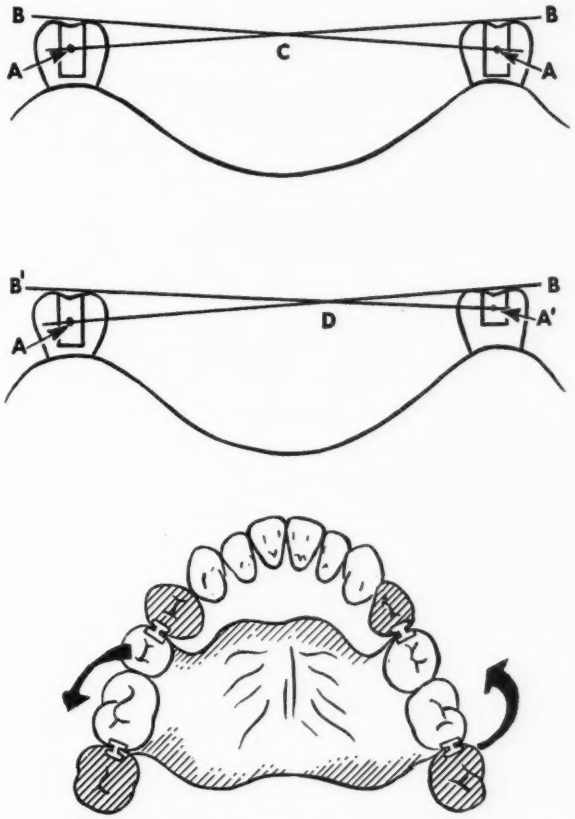



Fig. 12.—Given two attachments of equal length, with the same cusp form and plane of teeth, the centers of rotation of the precision attachments are at *A*. When force is applied on either side, lines *AB*—*AB* intersect at their midpoints (*C*). If one attachment is shorter than the other, its center is higher (*A'*), and lines *A'B'*—*AB* intersect at D. Forces are no longer in balance, and tipping can occur. Flat ridges are accessory factors which may aggravate the situation; whereas steep ridges help dentures offset the disbalance of forces.

pivoting point will be within the tooth. When it is more occlusally placed, less resistance is offered to horizontal displacement of the removable partial denture base, with diminished stabilization benefits to the tooth. Conversely, the longer the precision attachment, the less the partial denture base is displaced and, therefore, the greater the stabilization benefits. Obviously, then, if one precision attachment is shorter than its partner on the removable partial denture, the shorter one will tend to tip more readily and rise from its seat, rocking the partial denture base (Fig. 12). Horizontal displacement of the partial denture base is further

influenced by the shape of the edentulous ridges—flat ridges offer less resistance than angular ridges.[8]

Wear of precision attachments and spreading of the female portions take place more rapidly when posterior and anterior teeth are both supplied on the same removable prosthesis. When anterior teeth on such a partial denture are employed for incision, the force on them acts to displace the posterior teeth; conversely, when posterior teeth are functioning, they tend to displace the restored anterior teeth. The axis of rotation passes through the most anterior abutments, and the partial denture base rocks around the precision attachments (Fig. 13). The result may be discomfort, rapid wearing of parts, breakage of precision attachments, and general dissatisfaction with the restorative plan. Therefore, it is a general rule that all portions which can be replaced by fixed restorations should be excluded from the removable partial denture. The only permissible deviations from this rule occur when a periodontal overload is anticipated, and when a partial denture on the mandible occludes against a complete upper denture (Fig. 14). Even in this latter instance, clinical observation will indicate that when a clamping, and more particularly a grinding habit exists, such restorations may also exhibit the faults mentioned (Fig. 15).

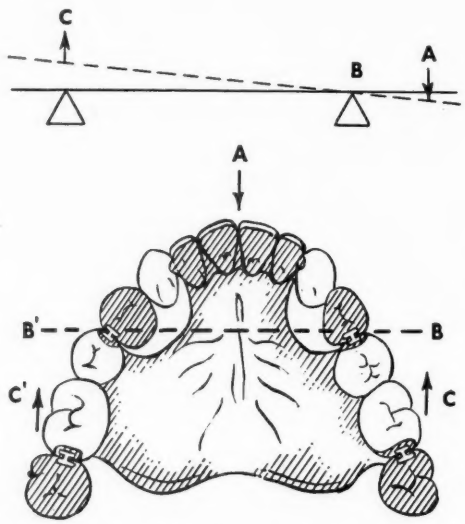



Fig. 13.—Instability resulting from replacing anterior teeth as part of the removable restoration. The partial denture tends to rotate around the anterior abutments *B*—*B'*.

There is a further important consideration: when a patient has the clamping or grinding habit, the mechanical or functional demands placed on dental restorations are far greater than for patients with normal tooth use. Where a precision-attachment removable partial denture is part of the restorative plan, clamping or grinding may loosen retainers of the partial denture and cause wear of the parts, requiring frequent recourse to expanding the head of the male portion of the attachments. Moreover, habits of such patients are usually of long standing. Previously the teeth may have been fuctionally impaired, and subsequently they

may be lost for the very same reasons. Despite this fact, fixation obtained by use of precision attachments together with fixed splinting of natural teeth in removable partial denture construction acts favorably on the periodontium, prolonging the life span of the abutment teeth.

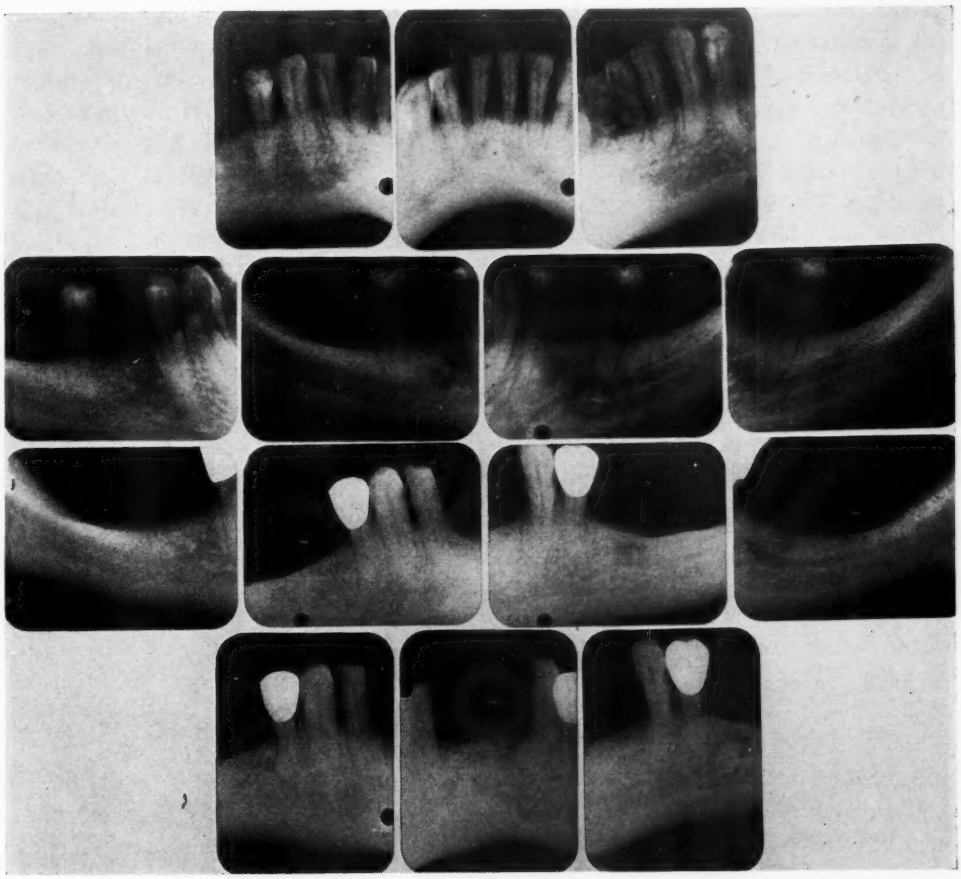


Fig. 14.—Above, *Roentgenograms before treatment* of the remaining teeth of a patient who wore a maxillary complete denture and mandibular clasp partial denture.

Below, *Ten years after treatment.* The mandibular left central, right central, and lateral incisors were removed, as well as the terminal left and right second premolars. A precision-attachment removable partial denture now replaces both the anterior as well as the posterior teeth. The mandibular anterior teeth *do not enter into any functional contact with the anterior teeth of the maxillary complete denture.* Compare the periodontal space and the bone height and density.

## PARTIAL DENTURE BASES

To gain lateral support for abutment teeth, the *removable partial denture base must be constructed of a rigid substance.* It should also be light in weight and compatible with the mouth tissues. Several metals fill these qualifications. The one selected must not introduce technical problems to the operation of soldering precision attachments to the metal base. *The palladium alloys are preferable* since their physical properties assure lightness in weight and rigidity, and permit easy

soldering. To add further to weight reduction and to improve esthetics, *the selected artificial teeth should be processed to the removable partial denture base with denture pink methyl methacrylate resin.*

Two objections to the use of palladium alloys are its darkish reflection through the processed pink acrylic resin, and discoloration of the exposed metal

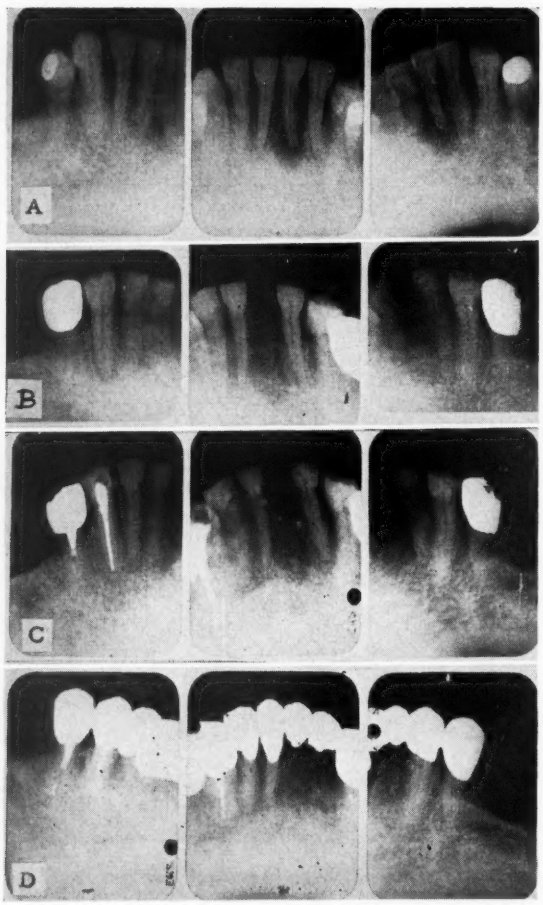



Fig. 15.—*A, Roentgenograms of a patient with a clamping habit before treatment.* Note that the pulp in the mandibular right central incisor had died—probably the result of trauma. The mandibular teeth occlude against a maxillary complete denture.

*B, One year after treatment.* A free-end removable precision attachment partial denture, employing single abutments, replaced the missing posterior teeth. Minimum pressure principles were not employed in making the impressions. Stress breakers were not used. The missing mandibular incisor was included on the partial denture. The pulp in the mandibular left canine had died.

*C, Two years later.* The pulp in the mandibular left first premolar had also died. All the remaining teeth were becoming increasingly mobile, particularly the abutment teeth. The partial denture also was loose and unstable.

*D, Roentgenograms of the same patient eight years after those in A, and five years after those in C.* Occluso-rehabilitation was instituted to offset the traumatic forces of the clamping habit. The mandibular right central incisor was removed because of advanced mobility. A fixed splint replaced the anterior teeth. This splint in turn acted as the abutment for a free-end precision attachment partial denture, constructed without stress breakers but employing mucostatic principles. Clinically, the teeth are now firm. Note the improvement of bone height and density.

after it is worn in the mouth. Both objections can be overcome by gold plating the partial denture base (a general advantage whenever processing acrylic resin to metal).[3] After the acrylic resin is processed to the gold-plated portions, all other areas of the partial denture are rhodium plated. The hard, dense, brilliant finish of rhodium not only obviates discoloration, but is also well tolerated by the tissues and permits easier cleaning of the partial denture by the patient. There is an objection to rhodium plating: if soldering is required to repair the partial denture, the rhodium surface will discolor and an unsightly base will result. No amount of polishing will remove this discoloration, nor can this surface be replated succesfully with rhodium. A simple solution has been found for this problem: *on completion of the repair, the discolored rhodium surface is given another gold flash plating, which can then be rhodium plated* with perfect results. This process can be repeated any number of times, if required.

All denture bases and bars should be simple in design. They must follow natural tissue contours and avoid the gingival areas around the teeth. Butterfly wings and intricate designs are unnecessary. In special circumstances where esthetics is paramount, an acrylic resin palate is permissible, provided a *rigid metal reinforcing bar* connects all precision attachments, and terminates at either the anterior or posterior border of the prosthesis.

Since a rigid, stable denture base is essential for buccolingual stability of the abutment teeth, it should be realized that two practices of the past which are still applied today are incorrect in principle. One of these practices is purposefully to arc the precision attachment to permit independent movement between the abutment teeth and the removable partial denture saddle. The other is to construct thin flexible bars and saddles to aid this movement further in order to stimulate the underlying tissues.[17]

## CONCLUSIONS AND SUMMARY

While the intracoronal precision attachment is the best means of achieving a physiologically functioning removable partial denture, there are special instances when its use may be contraindicated. Considerations of the general welfare of the patient supersede the physiologic and esthetic virtues of any restorative procedure. Poor health of the patient limits reconstruction that needs more than minimum time and operative procedures. Also, when tooth replacements are necessary for young persons, it is better to employ temporary means, awaiting the safer time for permanent replacements, rather than to risk pulp damage.

Precision attachments have additional advantages over clasp retainers. Since they have no extracoronal arms, they are more comfortable and neither trap food nor encourage tongue habits, and an esthetic result is easier to achieve. Patients who have worn both types of appliances attest to the greater comfort of removable partial dentures with precision attachments.

Forces exerted on abutment teeth by a removable partial denture prosthesis should be compatible with stresses best tolerated by the supporting structures of the teeth. Periodontally, the best-tolerated stresses are those resulting from the vertical component of force. Functional forces exerted on abutment teeth through

precision attachments approach this objective more closely than through other types of retainers. Since this type of prosthesis has a precise path of insertion and removal, it aids in tooth stabilization. If precision attachments become loose, they may be adjusted without disturbing the relationship of the partial denture base to the abutment teeth.

A rationale to improve the retention and stability of the precision-attachment removable partial denture by equalizing the lengths of the precision attachments in abutment teeth has been offered. The role of both fixed and removable prosthesis in the same arch has been discussed.

The value of fixation of abutment teeth for periodontal health has been demonstrated. Previously held concepts of the need for tooth movement in function are de-emphasized, and the importance of buccolingual stability in addition to mesiodistal stability has been stressed. In this regard, the importance of correctly coordinating the functional relationships of occlusion has been illustrated.

Clinical evidence is presented to support these principles. Many teeth with impaired supporting structures were returned to better health. This was manifested visually by reduction of mobility of the teeth; roentgenographically by improvement of the density and height of the supporting bone; and by diminished thickness of the periodontal space.

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# THE COPPER-BAND SPLINT

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THE COLD-CURE ACRYLIC resins are being used for making temporary restorations in many dental offices. Several techniques[1, 2] have been described expounding the virtues and many uses of this material, which has revolutionized the conduct and practice of restorative dentistry. The one shortcoming of the acrylic resins so employed, however, is the difficulty in obtaining a proper marginal fit. This results in inadequate retention, gingival inflammation, sensitivity, and wash-out of the temporary cement which permits decay.

The copper-band splint, first suggested by Dr. Lewis Fox,** and developed to its present refinements by Dr. Morton Amsterdam,*** has eliminated this pitfall to such an extent that it leaves little to be desired. Essentially, each temporary crown is made up of a copper band 3 or 4 mm. in height, tightly adapted to the subgingival marginal area over which acrylic resin is formed and retained by the band (Fig. 1). The result is a temporary restoration with proper marginal fit, with good gingival contour, with adequate retention, and free of any possibility of the cement washing out.

## THE BAND

Copper bands are inexpensive and come in many sizes. They are easily and accurately adapted in a few minutes' time, and make an ideal gingival finish short of a gold casting. Since copper oxidizes readily and this leaves a dark surface showing through the acrylic resin, the bands are annealed, gold plated, and opacified if desired. This can be done after the bands are fitted, but it is more convenient and time saving to have a set of bands annealed, plated, and opacified, ready for use. The copper should be as thin as is available so that a tight-fitting annealed band practically adapts itself to the shape of the preparation at the marginal area and requires very little burnishing. Once the band is fitted and festooned into the subgingival area, it is shortened to a height of 2 or 3 mm. supragingivally and feathered so as to be retained by the acrylic resin which will be formed over it and the prepared tooth (Figs. 2 and 3).

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Four basic techniques for forming the acrylic resin over the prepared teeth and bands will be described. In three of these procedures, the acrylic resin is polymerized in the mouth, which makes certain precautions necessary. With the bands in place over the prepared teeth, all exposed dentine is dried and lightly

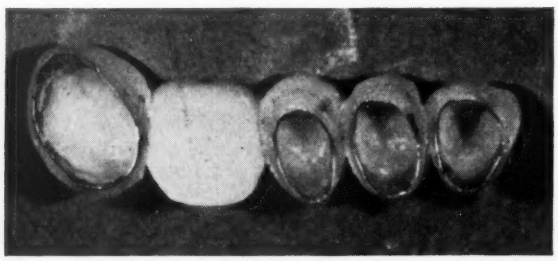

Fig. 1.—A finished copper-band splint showing the fine margins in copper.

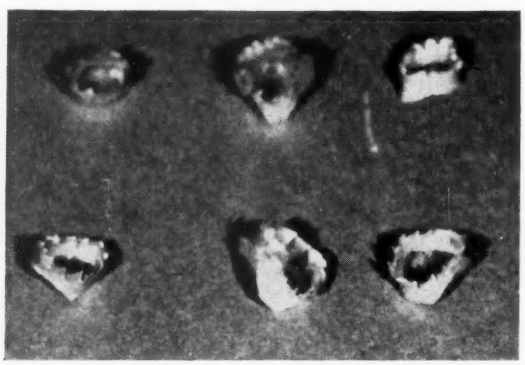

Fig. 2.—Copper bands festooned, shortened, and feathered before being replaced over the prepared teeth.

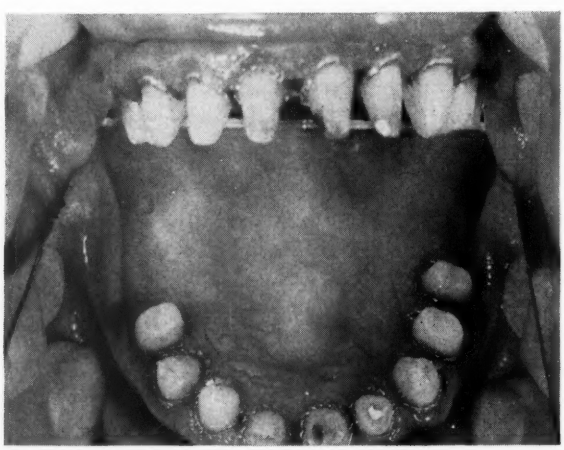

Fig. 3.—Copper bands in place on the prepared teeth before the preparation of the acrylic resin.

lubricated with petroleum jelly applied by a brush, and the adjacent teeth and soft tissues are more heavily lubricated with petroleum jelly by the finger. If any gold or acrylic resin is retained as part of the preparations, or is present in the adjacent unprepared teeth likely to come into contact with the fresh mix of acrylic resin, the lubricant may prove inadequate as a separating medium. Hazards, such as the fracture of a prepared tooth or loosening of an adjacent crown or bridge, may occur in the struggle to free the splint after setting. Tinfoil adapted over these materials will obviate these hazards. Burlew Dryfoil, which has one side gummed for stickiness when wet, serves nicely for this purpose. The second precaution is that a stream of cool water should be sprayed over the entire area while the acrylic resin polymerizes until it sets. This will eliminate any possibility of tissue burn or pulpal inflammation due to the exothermic setting reaction of the acrylic resin.

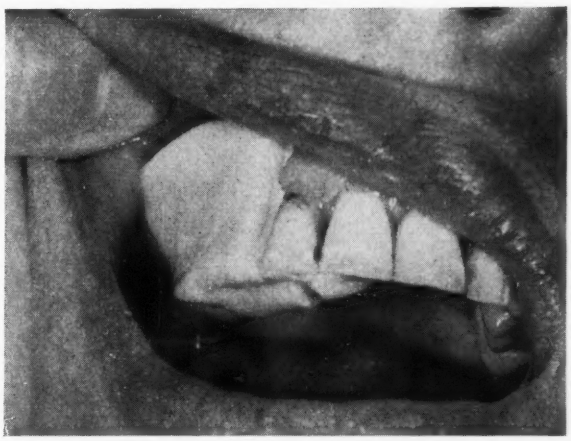

Fig. 4.—A mass of acrylic resin adapted over the prepared teeth and copper bands. Note the imprint of the occlusal surface of the opposing segment.

## DIRECT TECHNIQUE

This technique is convenient for a third to a half of an arch. It is particularly useful where there are missing teeth and/or discrepancies in the occlusion which can be corrected by first eliminating interferences in the opposing occluding segment to an anticipated proper occlusal plane for the copper-band splint being constructed.[3] If the opposing occluding segment is deranged to the point which requires reconstruction, it can be prepared later and constructed to the new occlusal plane already established. With the bands in place and the proper separating medium or media applied, a wad of cold-cure acrylic resin is adapted by hand over the entire area, including any missing teeth. Particular care must be taken to adapt the material around the gingival margins to assure its retention by the bands. The resin is best inserted before it becomes doughy and rubbery. The surfaces of the opposing teeth are lubricated with petroleum jelly, and the patient is guided into centric occlusion to make a definite imprint of the opposing teeth into the soft resin (Fig. 4). The patient is instructed to open and

close a few times in order to make sure the closures have not distorted the resin from good gingival adaptation. It may be necessary to readapt the resin in the gingival areas by finger pressure, and have the patient close and open a few times to check for any possible spring of the material. In the open-mouthed position, cool water is sprayed over the entire mass of resin until it sets. The acrylic resin mass is removed from the mouth (Fig. 5), the bare outer subgingival portions are painted in, and the bulk is trimmed to tooth form and anatomy. The temporary restoration is polished and set with temporary cement. If a band does not come off a tooth in the resin, retention will be assured by cutting out some of the intracoronal surface of the crown, relining it, and reseating the splint. To obviate this possibility entirely, one may adapt small amounts of softer acrylic resin, either by finger or by brush, over each preparation and band individually, before applying the large mass of resin.

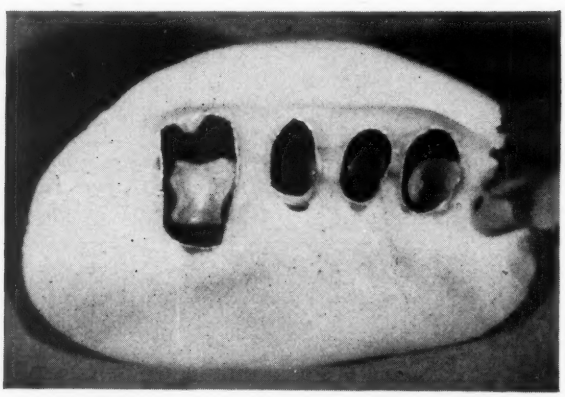

Fig. 5.—The copper bands are retained by the mass of set acrylic resin after removal from the mouth.

## THE SHELL TECHNIQUE

This procedure is indicated for anterior segments where esthetics is a major consideration, or for a full arch if it is being prepared in one setting. A cast of the patient's teeth is changed by both waxing-in and shaving off, where necessary, for maximum esthetics, by restoration of missing and malposed teeth, and by realignment of occlusal disharmonies which are influenced by the opposing occlusion, and its intended corrections.[2] Then an alginate impression, dyed for purposes of contrast, is made of the adjusted cast. Acrylic resin is painted into the impression by brush, forming an external shell only. After setting, the resin shell is removed from the impression. The gingival third of the shell is trimmed away to avoid interference by the copper bands in seating the splint, and to allow for the excess of a new mix of acrylic resin to be added as a reline in the mouth. The resin shell should not be prepared too long before it is used because warpage of the thin acrylic resin may be too great. Since the preparation of the shell itself takes but a short time, it can be done several hours before, or while the dentist carries out his operative procedures in the mouth. The com-

pleted shell is tried over the prepared teeth with the bands in place, and the patient is instructed to close into centric occlusion while the dentist examines it for interferences which might prevent its proper placement. Then the proper separating medium or media are applied, the shell is thoroughly dried, completely filled with a new mix of acrylic resin, and reseated. The excess material is adapted around the gingival margins by light finger pressure to secure contact with the copper bands. Any band coverage insufficient for retention can be painted in at once by brush. A fine stream of cool water is sprayed over the entire restoration until the acrylic resin sets. Then the splint is removed, the bare outer subgingival band areas are painted in, and allowed to set. The splint is trimmed, contoured to proper form, polished, and cemented with a temporary cement.

Fig. 6.—The copper bands are retained in an alginate impression. Note that the outer subgingival areas of the bands are painted in with plaster before low-fusing metal or stone is poured into the impression.

## THE ALGINATE TECHNIQUE[1]

An alginate impression of the area is made before operative procedures are begun, and set aside in a humidor. The teeth are prepared, the copper bands are tightly adapted, festooned, cut short, feathered, and seated. Using a No. 11 Bard-Parker blade, a generous amount of the gingival third of each prepared tooth area is cut out of the circumference of the alginate impression to allow space for the bands and the acrylic resin. A mix of cold-cure acrylic resin is tamped into the involved portion of the alginate impression. The impression is reseated in the mouth, with the unprepared teeth acting as stops for its proper placement. It is held in position while it is cooled with a stream of water until the resin is set. A water-cooled tray serves this purpose very nicely. The impression and the set acrylic resin are removed, the bare outer subgingival areas are painted in, and the splint is trimmed, polished, and cemented.

## THE EXTRAORAL TECHNIQUE

An extraoral technique is necessary for patients who are allergic to the free monomer during polymerization occurring in the mouth. I have observed some very severe reactions to these materials in spite of the precautions taken. Amsterdam[3] has minimized such reactions, first by adapting Dryfoil over the entire area, then seating the bands, and following with the acrylic resin. However, these patients show no reaction to acrylic resin if the polymerization is done on the laboratory bench.

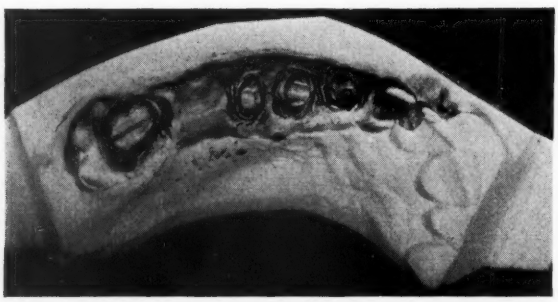

Fig. 7.—A laboratory cast showing recut copper bands in position on low-fusing metal.

After the copper bands are festooned and fitted, they are cut just short of the occlusal or incisal edge of each preparation, and feathered by three or four cuts which are bent away from the preparations. Then a Coe-Getz Checkbite Tray (designed to secure a reproduction of both opposing segments in occlusion in one tray) is loaded with alginate, seated over the copper bands, and the patient is instructed to close. After the impression material is set, the patient is instructed to open while the dentist holds the tray in place on the arch retaining the copper bands. Then, with a direct pull, the other half is snapped out in line with the long axes of the preparations. In one impression, the copper bands and the opposing occlusion are all properly related. The impression of the opposing occlusion is poured up in stone, and the bare outer subgingival circumferences of the copper bands are painted in with plaster (Fig. 6). The plaster allows easier removal of the bands after this half is poured, and it eliminates the necessity for the painting-in procedure after the acrylic resin is adapted by hand. After the plaster sets, either stone or low-fusing metal is poured to complete the cast. The low-fusing metal may discolor the bands enough to make replating necessary, but it does make them easier to remove, recut to a shorter gingival height, and reseat accurately, even if the bands are bent slightly in handling (Fig. 7). Stone poured into the band areas requires judicious handling while the bands are removed and reseated after recutting. The stone will always give an accurate reproduction of the preparations, however, while intracoronal surfaces of the low-fusing metal may have rounded tips and line angles which would reflect themselves as seating interferences in the mouth. With the bands in place on the cast, a mass of acrylic resin is adapted to the cast, and the opposing stone cast is brought into occlusal position. After the resin has set, the splint is finished as in the direct technique.

SUMMARY

The copper-band splint may be made by any one of the four techniques described. Their use is a most gratifying adjunct to the procedures of crown and bridge and occlusal rehabilitation. When all or most of the mouth is involved (Fig. 8) these splints make it possible to correct irregularities in occlusion and

Fig. 8.—Copper band splints are in position on all except the lower anterior teeth. Note tooth contour and anatomy, and the health of the gingival tissues.

support periodontally treated teeth. Gingival tissues may be maintained in maximum health. The durability and esthetics of the cold-cure acrylic resins, enhanced by proper marginal contour and fit, allow a comfortable interlude both for carrying on all procedures to insertion of the permanent appliances, and for provisional restorations over periods of many months, if necessary. This makes it possible to determine by both radiographic and clinical examination the advisability of retention or removal of questionable teeth.

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# ADVANCES IN FUNCTIONAL OCCLUSAL REHABILITATION

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THE PRESENT STATUS OF occlusal rehabilitation[1] is at a crossroads. Present techniques, designs, instruments, and conventional types of dental restorations must give way to the newer concepts, and to the understanding and increasing knowledge of the scientific functions of the mouth, its supporting structures, and the jaws.

Occlusal rehabilitation is actually the practice of fine dentistry, with emphasis on the establishment of good functional hinge occlusion. Therefore, it is our duty to try to rebuild a disordered dental mechanism into an orderly one (Fig. 1); i.e., one where the maximum tooth contact in function is attained.

We must be more diagnostically minded in order to attain the best prognosis for each individual patient. Since the mouth is the diagnostic mirror of the body, we must try to diagnose accurately and to plan each treatment problem so that the finished restorations will result in a maximum distribution of stresses over the greatest number of teeth and reduce the strain on each individual tooth to a minimum, thereby creating a state of physiologic tone and health of all teeth and their investing tissues for the greatest period of time. Hinge occlusion, stabilization, and functional jaw movements which aid the biologic maintenance of the periodontium and the supporting bone is our goal in occlusal rehabilitation.

## INDICATIONS FOR REHABILITATION

The conditions which require rehabilitation are:

1. Advanced attrition and abrasion and mutilation of the teeth.
2. Loss of contact due to the drifting of teeth.
3. Periodontal involvements where splinting is necessary.
4. Temporomandibular joint disturbances.
5. Elongation, extrusion, and loss of teeth which require extensive prosthesis.
6. Loss of vertical dimension. This can be restored only within the limits set by the interocclusal clearance that exists between the maxillary and the mandibular teeth when the mandible is at rest position. For every 1 mm. of increase in the interarch distance posteriorly, there is 3.1 mm. of increase anteriorly. We must avoid trying to make excessive changes in the vertical dimension.

Many advances have been made in the past ten years in the field of occlusal rehabilitation which have had their origin in experimental scientific research, as

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well as in practical clinical application. New techniques, theories, and concepts have been formulated to help the operator obtain his objectives with more certainty of satisfactory end result.

That new concepts of reproducing the functional movements of the jaw have helped solve the occlusion problem can now be demonstrated conclusively. It is possible to record and duplicate the movements of the human jaw and its function by means of the Transograph. The Transograph is an instrument that is a hinge bow which can be converted easily into an articulator by adding a few auxiliary parts. It simulates the functional relationships of the upper and lower jaws as they exist in the head. As an articulator, the Transograph becomes an instrument

**Fig. 1.—Left, Before treatment. Right, After treatment.**

for checking kinematically the interocclusal records made before and after the restorations are finished. Instead of the conventional condylar ball-slot, there is a condylar slide and slider assembly, of rectangular plate construction, with centering and locking screws. There is no rigid axis between the two condylar elements; they act independently of one another as do the condyles in the head. Transographics is not just another technique; it is an entirely new concept, and the Transograph is the mechanical means of applying this concept. Transographics is based upon kinematics (the actual movements of the jaw). "Where conventional theories stress an assumed importance of laterals and protrusives, Transographics contends that there are no laterals and protrusives in true function. Where conventional beliefs place great emphasis upon condyle paths, Transographics has demonstrated that the condyle paths have no functional value. Within the last three years, we have absolute proof that there are no radial lateral movements involved in natural function. We do not chew the way a dog wags his tail."[2]

In 1926, McCollum demonstrated a simple and effective method of locating the hinge axes which we must first establish as functional control centers if we are to work with function. Page and Albinson, inventors of the Transograph, have proved scientifically and clinically, respectively, that the hinge axis has to do with kinematics. Kinematics is motion. Motion is function. "Centric relation has to do with statics. It is, therefore, the complete opposite of kinematics."[2]

By the use of the split or broken hinge axis where the rotational control centers are not point centers in a rigid instrument with a single rigid axle between, but are individual and independent axial centers in a flexible instrument, the Transograph also becomes capable of reproducing the equivalent of the patient's Bennett movement. The Bennett movement is merely the natural bodily shift of the entire jaw during natural function, something that takes place readily because the condyles are loosely encapsulated.

## THE TECHNICAL PROCEDURE

After the diagnosis, evaluation, and treatment plan have been determined for a patient from mounted study casts, photographs, intra- and extraoral roentgenograms, as well as clinical and physical examinations, the operative work may be started.

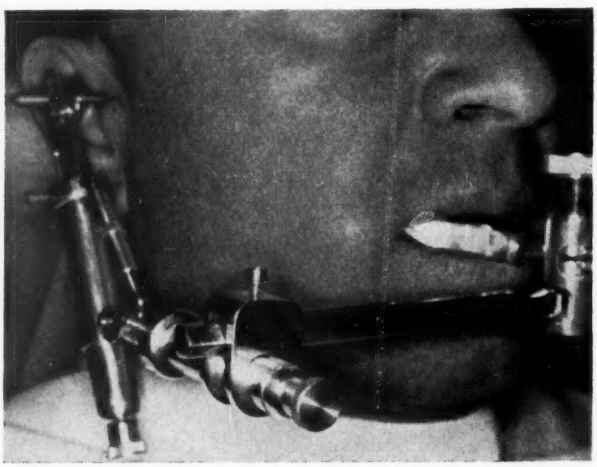

Fig. 2.—The hinge bow and clutch are in position for locating and registering the hinge axis.

A universal sectional metal clutch-tray is adapted to the lower dental arch. Some mixed impression plaster is placed in the tray and an impression of the lower anterior teeth is made. This impression is only necessary to hold the clutch rigid in the mouth. The hinge bow is fastened to the stem of the clutch. With gentle, rhythmic opening and closing movements of the jaw, *while the mandible is in extreme retrusion,* the condylar pins are observed. The sides of the hinge bow are adjusted until the pins turn over a single spot rather than move in arcs as the jaw opens and closes. These spots are tattooed on the skin with cinnabar, and represent the projections of the condylar rotational centers or hinge axes. A hinge axis is that axial center within each condyle which determines the arc of closure on which the cusps of the teeth meet in occlusion (Fig. 2).

After the hinge axes are located, the teeth are prepared under local, conductive anesthesia using Xylocaine hydrochloride (with epinephrine, 1:100,000), which we recommend as the most rapid, most profound, and safest of the local anesthetic agents.[8]

Individual impressions of prepared teeth are made in low heat compound and in graphite wax in preannealed and festooned copper bands. The compound is used for rigidity, and the graphite wax wash is used in the compound to record the sharp details of the preparations. The wax adheres well to the compound, yet it can be removed easily. These impressions are copperplated for accuracy, and dies are made. Temporary acrylic resin splints are made to protect the teeth. The dies

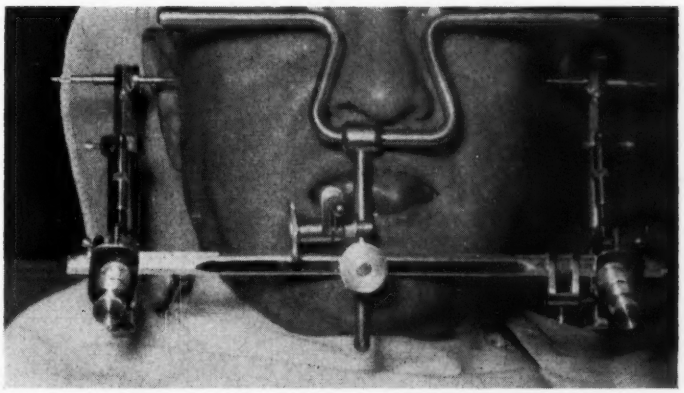

Fig. 3.—The head relator and the hinge bow assembly in position.

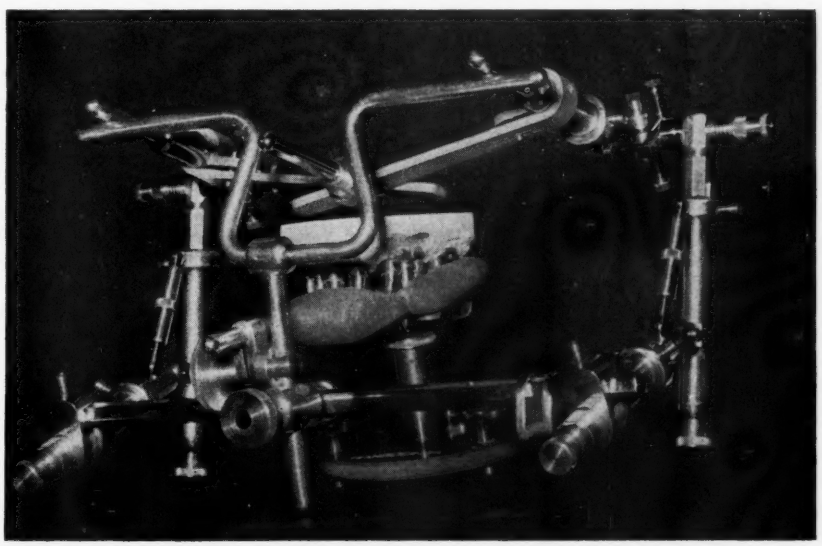

Fig. 4.—The articulator is formed around the hinge bow.

are trimmed approximately 0.75 mm. below the margins of the preparations. Gold thimbles are constructed on the dies. After these thimbles (or copings) are completed and fitted properly to the dies, they are sterilized and made ready for interocclusal records and for the impressions for forming the master casts.

Fig. 5.

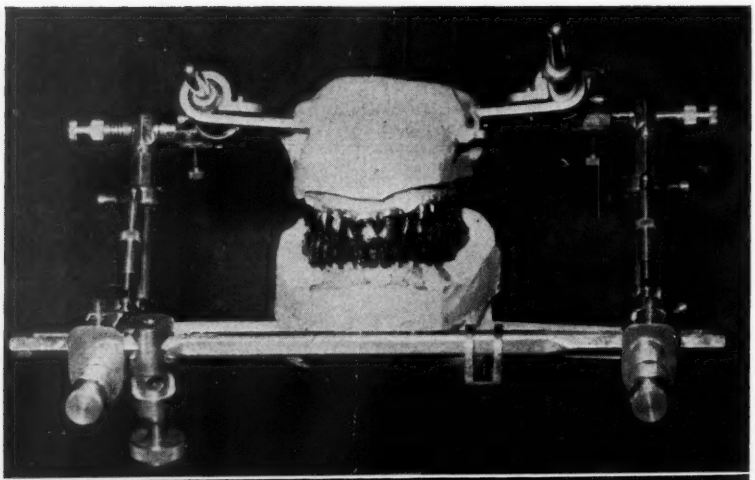

Fig. 6.

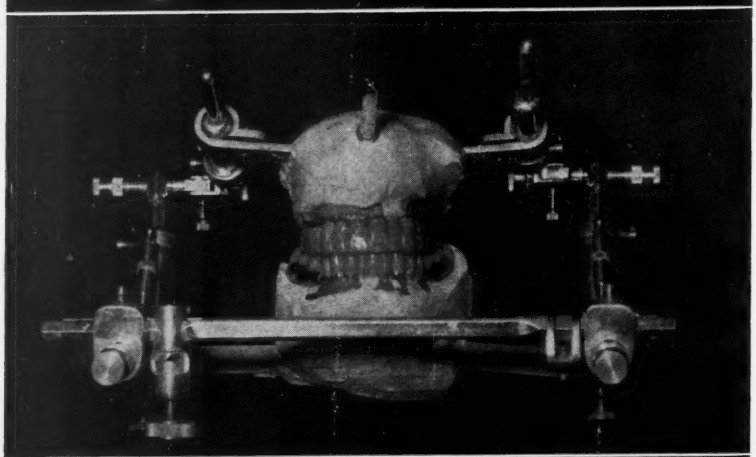

Fig. 7.

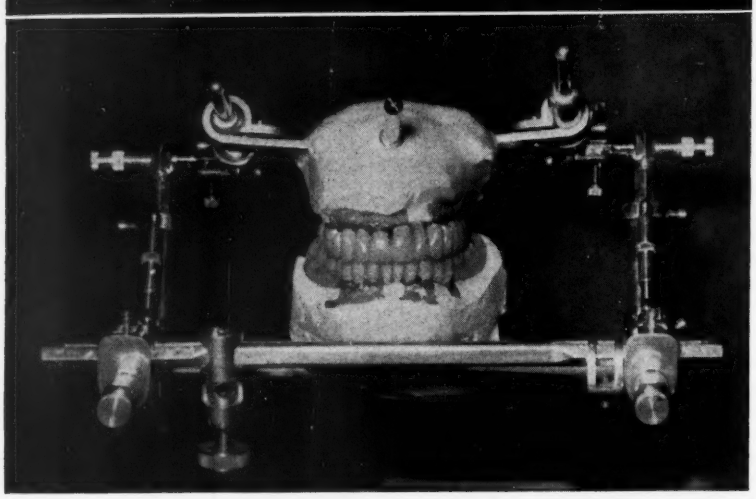

Fig. 5.—The restorations are waxed and carved on copings with the cam follower clevis and stem removed.

Fig. 6.—The restorations have been cast, and the teeth have been waxed for processing.

Fig. 7.—The processed and finished restorations.

The temporary splints are removed, and the individual thimbles are placed on their respective teeth. With the gold copings in place and well seated, functional interocclusal records with various thicknesses of wax are made with the mandible in the hinge position. It is made sure that the biting force does not cause the teeth or thimbles to penetrate through the wax. The wax is allowed to harden in the mouth for at least three minutes before removal, to avoid any distortion.

### THE HINGE BOW RECORD

Three or four layers of wax are attached to the bite fork and softened in water at 140° F. The bite fork is inserted in the mouth with the stem of the bite fork placed on the right side of the mid-sagittal plane of the patient's head. The patient is allowed to close gently into the wax so that the occlusal surfaces of the teeth and thimbles make only slight indentations in the wax. The head relator is attached to the bite fork stem by means of a two-way clamp. The head relator is adjusted so that its bars are parallel to and slightly below the pupils of the eyes.

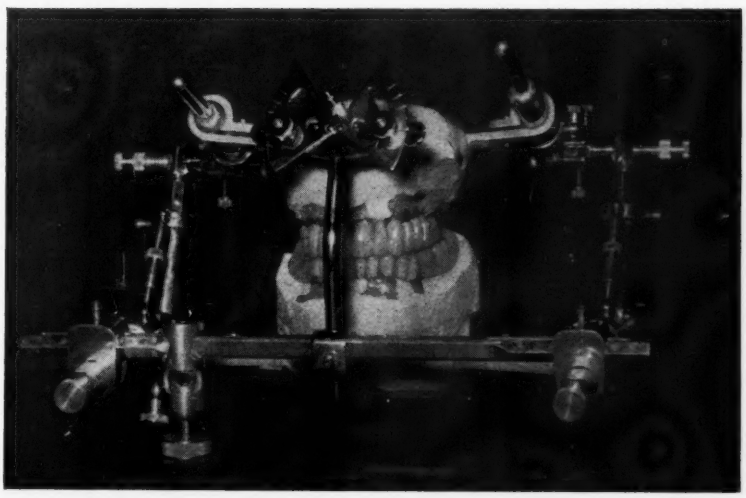

**Fig. 8.—The jaw movement guide assembly is attached for the refinement of the occluding surfaces of the restorations.**

The hinge bow is fastened to the head relator stem, and, with careful adjustment, the condyle pins are placed at the tattooed points marking the hinge axes (Fig. 3). After both pins and dots coincide, the hinge bow assembly is locked. The condylar pins are then removed, and the entire assembly, including the bite fork, head relator, and hinge bow, is removed as a unit. At this point, a kinematic reproduction of the patient's natural jaw relationships to a cranial plane is available for the laboratory technicians. With the copings still in place, the final impressions are made in Tru-Plastic, and master casts are made from these impressions. Now, the hinge interocclusal record is converted into an articulator (Fig. 4).

After the master casts are mounted on the articulator, the various interocclusal records made in the patient's mouth must check out. If the interocclusal records

are exact duplicates of the patient's hinge axes and maxillomandibular relationships to the cranial plane, they will fit as well in the articulator as they did in the mouth. The restorations are waxed up, carved at the predetermined vertical interarch distance, cast, and processed (Figs. 5, 6, and 7).

The restorations are remounted on the articulator after being completed. The jaw movement guide assembly (Fig. 8) is used at this time. It is set with an angle of closure between 55° and 60° to the cranial plane. This determines the functional transverse plane closure angle, and the horizontal planes along which the patient's mandible travels with respect to the maxillae in completing the final functional closing synergism. Thus, the patient's chewing cycle is reproduced on the articulator for the technician. This added movement will integrate automatically, and the patient's entire functional closing stroke may then be reproduced.

When the reconstruction restorations are inserted in the patient's mouth for the first time, they will fit and interdentate as accurately as they did on the articulator, and need little or no adjusting. The patient will accept the new vertical dimension at once because the Transograph provides an accurate mechanical reproduction of the functional movements of the jaws.

## CONCLUSION

Because of the newer advances in occlusal rehabilitation (including the biologic concepts of hinge occlusion, stabilization, and Transographics) as well as good scientific and common-sense understanding of each individual problem, we may look forward to a better era in dentistry. With adequate diagnosis, consideration of the Bennett movement, and balanced occlusion with cusps that will function in harmony with jaw movements, we can help to restore pathologic mouths to better health through scientific physiologic occlusion of the teeth.

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# THE DENTIST AND MALPRACTICE

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MALPRACTICE CONSTITUTES A VERY real threat to the members of all of the healing professions. Doctors of medicine were the first, and still are the primary, targets. Several thousands of them are sued each year in the United States. The incidence of such claims continues to increase. The plague has spread to involve dentists, osteopaths, chiropractors, naturopaths, and nurses; now even veterinary surgeons are being assailed with increasing frequency.

Public confidence in the professions is seriously affected by the ill-will and misunderstanding engendered by these frequently unfounded and sometimes malicious onslaughts against practitioners in the healing professions.

Doctors of Dental Surgery are not immune. It is true that relatively fewer malpractice claims involve dentists than physicians; and, of course, catastrophic injury cases are relatively infrequent in the field of dentistry. Nevertheless, malpractice claims against dentists are increasing in number, and many judgments in considerable amounts are being recovered against them. Many of these claims are in the field of prosthetic dentistry. As of the present, certainly, any dentist is unwise who does not give serious thought to avoiding grounds whereon he may be justly accused of malpractice, and who does not routinely take all the available precautions to safeguard himself against the unjust malpractice accusation.

The law requires that every person act with due or ordinary care toward his fellows. Failure so to act constitutes negligence. Due or ordinary care means the degree of care commonly possessed and exercised by the ordinarily prudent person in the conduct of his own affairs. Everyone must meet that standard. Any person in his everyday activity may be adjudged negligent if he fails to do something that the average person would do or does something that the average person would not do in a given set of circumstances.

There is a legal standard, too, which the professional man must meet in carrying out his professional activities. The standard is always what the ordinary, reputable practitioner, in the same field of practice, in the same or in a similar locality, would do and what he would refrain from doing, in caring for a similar case.

The failure of a practitioner to meet the standard of practice, injury resulting to his patient, constitutes professional negligence. This is called malpractice.

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The principles of law which are applicable in a malpractice accusation, and in the trial thereof, are the same whether the defendant is a physician or a dentist. Whether a practitioner is to receive a fee or is to render his services gratuitously in no way affects his legal duty.

## RESPONSIBILITY OF DENTISTS

When the dentist-patient cases are analyzed,[1] it is found that the courts almost uniformly hold that a dentist is bound: (1) to use reasonable care in the performance of his professional services; (2) to act according to his best professional judgment in treating his patients; and (3) to possess and exercise that degree of skill and learning which is ordinarily possessed and exercised by members of his profession in the same field of practice in the same general neighborhood or in similar localities. Failure to perform his duty in these respects is regarded as malpractice. But if the dentist has fully complied with his duty and has exercised the requisite degree of care and skill, he is not liable for mere error of judgment, if there is any, in the selection of method or procedure to be followed. The practitioner is justified in his selection of a method of treatment if it is one that would be approved by even a respectable minority of his colleagues in the locality. However, he cannot excuse himself on the theory of mere error of judgment if he fails to inform himself of facts by a proper examination.

## COMPLAINTS AGAINST DENTISTS

From an analysis of the claims and actions it is determined that the following allegations are among those which most frequently appear in complaints brought against members of the dental profession: slipping instruments; broken needles; root left in socket; lack of consent; extraction of wrong tooth; flying fragments entering respiratory passages; injury in fitting, or from ill-fitting dentures; infection from use of unsterile instruments; fractures and dislocations of jaw; death from anesthetics; and failure to fulfill duty to advise patient of injury or of condition, such as a fragment of broken needle remaining in tissues. The essence of the complaint is, always, that the accused dentist failed to possess or to exercise the degree of skill and care commonly possessed and exercised by other reputable dentists in the locality.

One who holds himself out as an expert in a particular field of dentistry is held to a higher degree of care and skill than an ordinary practitioner.[2] One who claims to be a specialist must possess and exercise the care and skill of the specialist in the particular field of practice.

Unless he so expressly agrees and undertakes, a dentist is not held to warrant a cure,[3] or a painless, or even a successful, operation. Nonsuccess or unsatisfactory results will not alone establish the essential elements of legal detriment. This is well illustrated in a case[4] in which the court said that a dental surgeon cannot be held responsible, any more than a physician or surgeon, for the failure of the patient to respond satisfactorily to treatment or to make rapid progress toward recovery, provided he used the treatment recognized and customary in the profession and employed reasonable skill and diligence.

## CONSENT

It is the duty of the dentist to follow explicit instructions when such are given him by the patient. If he exceeds the instructions given him he is guilty of a technical assault. And this, regardless of the degree of care and skill employed, constitutes malpractice.

The patient must always have authorized or consented to the treatment which is administered. If the procedure to be undertaken is extensive or hazardous, it is highly desirable to have the consent in writing. Oral consent is valid but, obviously, proof of consent is easier when the authorization is in written form. Of course, consent is, to a degree, implied in the very fact that the patient is in a dental chair. A parent or guardian is the source of authorization of work to be done on a minor.

In specific reference to the problem of consent, the following cases are cited: (1) In a Pennsylvania case,[5] it was held that a dentist removing a patient's teeth without authorization is liable for damages occasioned by the assault, notwithstanding the use of the required degree of skill. (2) In a New York case,[6] in which the plaintiff testified that he instructed the defendant dentist to extract a certain tooth in which there was a cavity, and that, while under the influence of gas administered by the defendant, the defendant extracted a different tooth and afterward extracted the right tooth, it was held that the plaintiff had made a prima facie case of malpractice.

In reference to following instructions, there is another New York case[7] of particular interest. In this case, the patient's regular dentist advised her to consult the defendant, a specialist in oral surgery, and to have him remove the lower left first molar. The patient sought damages for the extraction of a tooth other than the one she had indicated. Judgment was given for the patient in the trial court. Upon appeal the judgment was reversed and a new trial ordered. This was apparently on the theory that there was in fact no special contract; that the defendant made an independent examination and determined that the trouble was with the second molar, first and third being normal; and that there was no showing that the defendant had not acted in a manner consistent with the standards of practice in his special field.

In passing, let it be pointed out that the use of a consultant always affords a great degree of protection to all concerned. Malpractice suits are rarely lost wherein it is shown that an independent consultant was in contact with the case during what is established to have been the critical period.

It is presumed in all instances, in the absence of evidence to the contrary, that a physician, surgeon, or dentist has performed the duty undertaken by him with reasonable care and skill. Negligence or want of skill must be affirmatively proved.[8] The rule is well established that a dentist cannot be held liable for the death of a patient under his treatment where there is no evidence to show negligence or lack of skill on his part to overcome the prima facie case in his favor.

## CONTRACTS

A dentist is not an insurer of results unless he makes himself one by his special contract. That he may unwisely make himself an insurer is illustrated in a

New York case,[9] in which it was held that a dental surgeon, who entered into a special contract to extract every part of four teeth, could be held liable for breach of contract when a gold inlay in one of the teeth became detached during extraction and fell into the patient's throat and lodged in his body; and this regardless of whether the dental surgeon was negligent. The court went on to say that a dental surgeon is liable to a patient only for failure to exercise ordinary care and skill, in absence of special contract, but that he may contract with the patient to accomplish a particular result.

However, a dentist does not impliedly warrant to his patient that he himself will do all the work involved in the construction of a denture. Courts will take judicial notice of the common practice in the dental profession whereby a dentist may make an impression and do all things that have to do with the fitting of teeth in the mouth and then send the denture elsewhere for processing and polishing.[10]

## TESTIMONY

In the ordinary malpractice action, if the patient is to prevail, he must present expert testimony to establish that the dentist, in the professional service rendered, failed to meet the standard of practice in the community and that, as the result, the injury complained of occurred. The standard of practice, let it be repeated, is always what the ordinary, reputable practitioner in the locality, in the same field of practice, would do and what he would refrain from doing in the care of a particular type of case.

A lay witness may testify concerning things which were actually done, but as to the propriety of those things, the expert is the only legitimate witness. What constitutes, for example, good practice either in diagnosis or in treatment, is a question for the expert witness and can be determined only by his testimony. As to matters which are within the common knowledge and understanding of laymen, no expert testimony is necessary or required. Whenever a practitioner, by his own statement or admission, acknowledges fault or negligence, no expert testimony is required.

The following case extracts illustrate some of these points:

1. A dentist is a "dental surgeon" and the rules of law applicable to the care owed by physicians to patients apply to him.[11]

2. A dentist, in prescribing for or treating a patient, may adopt any approved method recognized by the profession generally, or by any respectable minority thereof.[12]

3. In *Inglis v. Morton* (Wash.),[13] it was held that in a malpractice action against a dentist, the law is well settled that a bad result is of itself no evidence of negligence.

4. In an action against a licensed dentist for malpractice, the presumption is that he performed his professional duties with the requisite degree of skill and care, in the absence of evidence to the contrary.[14]

5. If a dentist, in the exercise of the professional care and skill required of him as such, discovers, or should know or discover, that the patient's ailment is

beyond his knowledge or technical skill or ability or capacity to treat with a likelihood of reasonable success, it is his duty to disclose the true condition to the patient or advise him of the necessity of other or different treatment.[15]

6. A dentist may be guilty of malpractice when he negligently fits dentures in a patient's mouth, when the services result in physical injury over and beyond the injury and damages which may naturally ensue from normal and proper fitting and installation of artificial teeth.[16]

7. A dentist in practicing his profession must use not only requisite care and skill in a particular operation, but he must also give such subsequent treatment to the patient as the necessity of the case demands, in the absence of any special agreement to the contrary.[17]

8. The fact that an operation by a dentist was followed by an infection raised no presumption of want of proper care or skill.[18]

9. In *Budoff v. Kessler,*[19] a New York case, it was held that dentists were not required to institute a new professional relationship when, after termination of dentist-patient relationship, the patient returned and demanded treatment to heal a condition allegedly caused by the dentist's negligence.

10. In a Maryland case it was held that the patient's consent before extracting other teeth was necessary if he had instructed the dentist to extract baby roots only.[20]

11. In *Steinke v. Bell* (N.J.),[21] it was held that expert testimony was unnecessary in a case in which the defendant dentist removed an upper right lateral incisor although he had been engaged to remove only a lower left second molar.

12. In *Mitchell v. Poole* (Mo.),[22] in which a hypodermic needle broke off in the plaintiff's jaw while the defendant was anesthetizing her before an extraction, it was held that an instruction that negligence could not be presumed from the mere fact that the needle broke was properly given, since otherwise the jury could have decided the question upon pure speculation and conjecture.

13. In many cases it has been said that a dentist is bound to bestow upon his patient that degree of care, skill, and diligence which dentists in his line of practice in the same general neighborhood or in similar localites ordinarily exercise in like cases.[23]

14. In a Federal case,[24] the court said that, under Ohio Law, malpractice is established if a preponderance of the evidence shows that the injury complained of was caused by the doing of some particular thing that a dentist of ordinary skill would not have done under like conditions, or by the failure or omission to do some particular thing that such a practitioner would have done under like conditions, and that the injury complained of was the direct result of the doing or failing to do some one or more of such particular things. (All of this by testimony of expert witnesses.)

15. In another Federal case,[25] in a malpractice action against a dentist, it was held that where the expert evidence went only so far as to show that cancer on plaintiff's tongue might have resulted from any one of several causes, for only one of which the defendant could be held responsible, such evidence failed to make out a case for the jury.

16. In *Simone v. Sabo* (Cal.),[26] the Supreme Court of California held that in a malpractice action brought against a dentist who was a general practitioner, an

instruction (given to the jury) that a general practitioner who undertakes service in a special field where there are specialists available has the duty to possess that degree of learning and skill ordinarily possessed by such specialist, was subject to criticism in that it failed to state that there was a duty to refer the patient to a specialist only if, under the same circumstances, a reasonably careful and skillful general practitioner would have done so.

17. In *Stallcup v. Coscarart* (Ariz.),[27] in which judgment in the trial court was given for the plaintiff against the defendant dentist, the Supreme Court reversed the judgment and remanded the case for new trial because it was held that the trial court's error in refusing to give correct instruction requested by the defendant as to proof required to establish liability for malpractice constituted reversible error.

18. In a number of cases, courts have said that since dental treatments inevitably cause some pain and violence, proof of causation (proximate cause) involves the problem of separating the natural consequences of the treatment from those results arising from the defendant's alleged negligence or want of skill.[28]

19. In a Louisiana case,[29] it was held that it is negligence per se to allow any part of a tooth to remain in a patient's mouth (no expert testimony is necessary). Parenthetically, in this connection, a Pennsylvania case[30] is of importance. In this case it was held that a dentist was not negligent in failing to extract the root of a pregnant woman's tooth on the same day he broke the tooth off.

20. In a New York case,[31] in an action to recover damages because of a fracture of the jaw due to an allegedly negligent attempt of the dentist to extract a wisdom tooth, in order to show that the treatment was unskillful, it was held necessary that the plaintiff call an expert witness to describe the approved methods of dental practice at the time when the injury was inflicted.

21. In a Connecticut case,[32] the court said that where the exercise of proper professional skill by the dentist is in issue, expert testimony tending to establish want of proper care is generally essential to recovery.

22. In a Massachusetts case,[33] it was held that evidence of the dentist's admission that it was his fault that a hypodermic needle broke, made negligence a question for the jury.

23. In a New York case,[34] in extracting a tooth the dentist used a mallet and chisel. The patient's jaw was broken. There was testimony that the dentist said, "Well, I did break your jaw. I guess I hit you a little too hard." Expert testimony was not required in this case.

24. In *Kolb v. Bergelin* (Wis.),[35] it was held that if the dentist agreed to construct dentures satisfactorily, the patient was not obliged to pay therefore if dissatisfaction was real and in good faith.

25. In *Berry v. Summers* (Idaho),[36] the Supreme Court of Idaho held that a statutory amendment including in the definition of the practice of dentistry the constructing, correcting, and repairing of dental prosthetic appliances or dentures is unconstitutional because it prohibits a legitimate occupation. The Court said that the Legislature may not prohibit a calling unless it is inherently injurious to the public health, safety, or morals, or has a tendency in that direction.

26. Where a dentist, claiming that his woman patient owed him $33.00 for denture work while she claimed that she owed him only $22.00, kept such patient in his office, locking the door, to force her to return the denture or to pay what he claimed, he falsely imprisoned her by unlawfully depriving her of her liberty and was liable therefor.[37]

### DISCLOSURE OF FACTS TO THE PATIENT

There is no doubt but that a physician or a dentist owes a duty to make a sufficiently full disclosure of all the pertinent facts of a case so that the patient may be in a position to decide, intelligently, whether or not to submit to further or to any treatment. This conclusion is supported in many cases:

1. In an Arizona case,[38] the court said that the relation between the plaintiff and the defendant was confidential, calling for frank and truthful information from the dentist to his patient, and the dentist, in keeping from his patient knowledge of the true condition of his jaw and teeth, violated a very sacred duty he owed him.

2. In an Iowa case,[39] it was said that a dentist, fracturing a patient's jaw in extracting a tooth, owed a duty to notify the patient of the fracture in order that she might have it treated promptly.

3. In a Massachusetts case,[40] it was held that a dentist, who for any reason is unable personally to exercise the skill ordinarily exercised by dentists in the community, may be under a duty to advise the patient to employ another dentist who is better equipped.

4. In another Massachusetts case,[41] the court said that the mere breaking of a Novocain needle inserted by a dentist in a patient's jaw is not evidence of negligence; but that, on the evidence, the jury would have been warranted in finding that the dentist should either have removed the broken needle or informed the patient of its presence so that she could have it removed.

### BROKEN NEEDLES

It should be noted here that the decisions of the courts in cases in which needles have been broken off in the mouth, are not uniform over the country. In Washington, for example, in such cases, a greater burden is imposed upon the defendant dentist. In one such case,[42] in which the defendant dentist was found liable, a hypodermic needle having broken off in the patient's mouth, the Washington court said: "Surely such results are unnecessary and are not to be anticipated if the proper degree of care is exercised by dental surgeons. If such accidents were frequent, the dentists would quit using hypodermic needles and employ some other method for deadening pain."

### NEGLIGENCE

The doctrine of *res ipsa loquitur* is of increasing importance in the law of malpractice. *Res ipsa loquitur,* literally, "the thing speaks for itself," is a doctrine of the general law of negligence. It is held applicable whenever one person is injured by an instrumentality entirely in the control of another person, the use of which, if the person in control exercises due care, does not ordinarily result in injury.

Generally, as has been indicated, the proof of a dentist's negligence must be established by the testimony of dental expert witnesses. The application of the doctrine of *res ipsa loquitur* creates in the case an inference of negligence on the part of the defendant, and it relieves the plaintiff of the necessity of proving the alleged malpractice by the testimony of experts. It places on the defendant the burden of making explanation, if he can, to offset the inference of negligence, and, by the majority rule, a question is created for the jury, regardless of any and all evidence presented by the defendant.

The doctrine of *res ipsa loquitur* has been held applicable in the malpractice field chiefly in the following types of cases: (1) slipping instruments; (2) sponges left in the tissues; (3) burns from heating modalities; (4) x-radiation injuries—generally limited to cases wherein the x-ray is being used diagnostically; (5) infection through the use of an unsterilized needle or instrument; and (6) injury to a portion of a patient's body outside the field of treatment or operation.

A few cases are listed in which the doctrine of *res ipsa loquitur* was held applicable:

1. In an Indiana case,[43] wherein an x-ray machine fell on the patient while he was in a dental chair.

2. In a Federal case,[44] where the dentist's drill slipped, penetrating the floor of the mouth.

3. In a Minnesota case,[45] in which a patient's tongue was cut by an electrically driven instrument.

4. In an Iowa case,[46] where particles lodged in the respiratory passages of the patient while the dentist, with the use of an anesthetic, was extracting a tooth. But an Illinois court,[47] with similar facts, handed down a contrary decision.

On the other hand, the doctrine of *res ipsa loquitur* was held not to apply in the following:

1. Where, in an Indiana case,[48] an action was brought against a dentist for allegedly causing death through the use of an anesthetic.

2. Where, in a Virginia case,[49] roots of plaintiff's teeth were allowed to remain in the jaw after extraction of teeth.

3. In an Alabama case,[50] it was held that the doctrine does not apply to pain and unfortunate consequences attending the extracting of a tooth.

4. In a Missouri case,[51] the court said that the doctrine cannot be held to apply to dislocation of the jaw during tooth extraction, where there is evidence that dislocation of the jaw may occur where a tooth is being extracted with proper care.

## DENTIST'S LIABILITY

A dentist's liability for negligence or malpractice extends to acts or omissions of his employees, within the scope of the employment. He is also, of course, liable for the professional acts of a partner. Care should be exercised in the selection of assistants, and in the delegation of duties to them.

Whenever a practitioner responds to a request that he render professional services without limitation as to time or the nature of the service, he is legally bound to give, or to see to it that there are given, such services as the case requires

until they are no longer needed, unless he is sooner discharged or unless he withdraws from the case. Reference is made to a Montana case,[52] in which it was held that a dentist, who had extracted a tooth, owed a duty to the patient to see that the patient did not leave his office while there remained danger of hemorrhage; and the further duty, on being advised of the patient's condition, immediately to render such care and attention as was reasonably necessary to relieve the patient's condition.

There must be, in all cases, sufficient observation, sufficient treatment, and sufficient follow-up, in accordance with the standard of practice, in the exercise of good professional judgment.

## POTENTIAL MALPRACTICE CLAIMS

It is clear that no practitioner can be justly accused of malpractice if he cares for his patients with meticulous attention to the requirements of good practice. However, no course of conduct on his part can safeguard him from an unjustifiable claim or suit. Whenever there is, following the rendition of professional services, a less than perfect end result, a potential malpractice claim exists. A poor result plus the unfounded suggestion that the treatment administered was at fault equals another malpractice claim.

A high percentage of all of the malpractice cases are precipitated by the criticism of some practitioner of the work done, or the result obtained, by another practitioner. It is obviously of the most vital importance that unethical, destructive criticism be stopped.

For a practitioner, it is a miserable experience to be sued for malpractice. His reputation and his professional integrity are assailed and put in jeopardy. The mere filing of a malpractice action is injurious to him. In addition to the mental and emotional stress and loss of time to the individual, the increasing number of unjustified claims is imposing a mounting burden of costs. Further, and not of the least significance, there is, inevitably, a lowering of public confidence in the profession.

It is declared, against any contradiction, that most of the malpractice claims which are brought against members of the healing professions are not meritoriously foundationed—that is, the majority of such claims are not honestly and factually justifiable. Moreover, the targets of these actions are not exclusively or generally charlatans or quacks—to the contrary, many of the defendants in these actions are found to be, in their respective fields of practice, above the median in experience, reputation, and ability.

## SAFEGUARDS AGAINST MALPRACTICE SUITS

Those who have realistically viewed the malpractice problem realize that it can be solved only by the affirmative and purposeful action of the professional groups. Practitioners must learn what they may do to safeguard themselves and must put into effect every possible precaution against unjust malpractice accusations. The vast majority of malpractice suits can be avoided by scrupulous attention to the

requirements of good practice, if this is accompanied by an equally scrupulous care for the reputation of fellow practitioners.

It has been suggested that county dental societies should establish grievance committees before whom complaints of dissatisfied patients may be heard and considered.

Such committees, no matter how called, are now functioning in several localities across the country. Their duty is to hear and to investigate the complaints of patients respecting professional care rendered by attending dentists, and/or the allegedly excessive fees charged by them.

## COMPLAINTS ABOUT FEES

In so far as their activity respecting fee complaints is concerned, grievance committees can serve a great good to all concerned. Respecting fee complaints, it is found in the majority of cases that the fees complained of are fair and reasonable. Most of these cases can be satisfactorily disposed of by simple explanation to the complainants. In those instances in which it is found that the fees charged are unusual, unreasonable, or excessive, it may be suggested to the parties that the matter be compromised, or it may be directly suggested to the dentist that the fee be fairly and appropriately reduced. Actual experience proves that the results are generally satisfactory.

It is pointed out that, unless the patient has specifically agreed to pay a definite sum for the services, an implied contract arises which obligates him to pay the reasonable value thereof.

## COMPLAINTS OF PROFESSIONAL CONDUCT

The handling of complaints of professional conduct poses a more difficult problem. Patients come before professional conduct committees complaining of professional service which has been rendered them. Some of these patients have suffered unusual complications; some present cosmetic defect or functional disability; and not a few have already been told by some other person that the treatment rendered was improper or negligent.

It is certain that the grievance committee dealing with complaints of treatment will sometimes find it difficult to convince the complainant, even though it is the actual fact, that the attending dentist is not responsible for an obviously bad result. It must be borne in mind, too, that a further charge may arise in some of these cases. The complainant may allege that the committee has conspired to conceal his right of action or has, in some other way endeavored to mislead him to his injury.

The fact that there is some reluctance to accept the intervention or to approve the functioning of professional conduct committees is understandable. There is a fear that the activities of grievance committees may result in an increase in the incidence of malpractice claims. There will inevitably be the occasional case in which the opinion of the committee, if honestly formed, will be against the interest of the dentist.

If the grievance committee is to serve a constructive purpose, it cannot start with the preformed conclusion that the doctor is always right, nor can it conceive that its function is routinely to "whitewash" those who have complaints brought against them. An impression that the doctor is consistently given overly favorable treatment by the grievance committee is likely to be created and to circulate in the community, with injury to the society's public relations, unless the committee is competent and fair, and unless it deals intelligently and patiently with the complaints and with the individuals before it.

No claim or suit should arise when an attending dentist has fully met the legal obligation owed his patient. The patient may not be in a position to know whether the required standard has been met or not. In many cases, after complete investigation, the grievance committee has the opportunity to inform and to reassure the patient—to make it clear that the dentist does not deserve the criticism and blame which is being cast upon him.

On the other hand, instances of actual malpractice do occur and, if complaints are to be satisfied and the public interest served, the professional conduct committee cannot avoid the ultimate issue—the question whether or not the attending dentist actually fulfilled his legal duty to his patient.

## ATTITUDE OF GRIEVANCE COMMITTEE

It is obvious that the professional conduct committee must possess knowledge of the legal implications involved if it is to deal fairly and soundly with the controversies brought before it. Unless the committee possesses such knowledge and unless it is authorized to deal effectively and realistically with all matters given consideration, it should not function at all. Poor and inconclusive handling of professional conduct complaints cannot but injure the professional group by creating a serious public relations problem and by adversely affecting the insurance interests of the membership.

What is the grievance committee to do with the case in which the evidence suggests or conclusively indicates malpractice? In considering this question it is assumed, a priori, that the committee or the dental society has publicly invited dissatisfied patients to file complaints; that complete investigation is made of every complaint; that the committee understands the legal principles involved; and that, in the given case, the committee has concluded that the dentist complained of did not, in his care of the complaint, act in a manner consistent with the standard of practice in the community.

The committee, having decided in a given case that the attending dentist did not care for the complaint in accordance with the requirements of good practice is now faced with the problem—shall the patient be so advised? And if so, in what manner and to what effect?

It seems clear, in the circumstances outlined, that the patient and the dentist must be informed of the committee's conclusions. Further questions, however: Shall the patient be advised to sue the doctor? Shall the committee offer to help in the legal action? Shall the committee offer its good offices to attempt to effectuate a settlement of the matter? Or shall the committee simply report its conclusions

to the patient, either pointing out or not that it is now a matter for the patient's decision as to whether or not further action shall be had?

It may be pointed out that the record made by the grievance committee, in a given case, may be subpoenaed into court and that such a record might in itself make the case for the plaintiff.

## INSURANCE

Most dentists protect themselves with professional liability insurance. In policies of this type, there is generally a clause which provides that the control of the defense of claims shall be in the hands of the carrier—that the insured or any other person may not make an unauthorized settlement. It is likely that the carriers will, sooner or later, manifest an interest in the functioning of grievance committees.

It is questionable whether a grievance committee, dealing with other than fee complaints, should function in any dental society, except and unless such committee is developed and functions as an integral part of a county association malpractice program.[58]

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46. Whetstine v. Moravec (Iowa), 291 N. W. 426.
47. Bollenbach v. Bloomenthal, 258 Ill. App. 305.
48. Robinson v. Ferguson (Ind.), 22 N. E. (2d) 901. And see: Ernen v. Crofwell (Mass.), 172 N. E. 73; Smith v. McClung (N. D.), 161 S. E. 91.
49. Alexander v. Hill (Va.), 6 S. E. (2d) 661.
50. McTyeire v. McGaughy (Ala.), 130 So. 784.
51. Hill v. Jackson (Mo.), 265 S. W. 859.
52. Donathan v. McConnel (Mont.), 193 Pac. (2d) 819.
53. Regan, L. J.: Doctor and Patient and the Law, St. Louis, 1949, The C. V. Mosby Company, Chap. XX.

# OCULAR PROSTHESIS

ROBERT B. WELDEN, D.D.S.,* AND JOHN V. NIIRANEN, D.D.S.**

*U. S. Naval Dental School, National Naval Medical Center, Bethesda, Md.*

THE ART OF MAKING artificial eyes has been known to man from the days of the early Egyptian and the Peruvian Indian, but not until the time of World War II, and the development of the refined plastics which came then, has there been a satisfactory esthetic ocular prosthesis.

The *custom-built,* hand-painted, and individually constructed acrylic resin artificial eye has proved to be the most satisfactory ocular replacement. Custom building, however, necessitates the services of a skilled artist for duplication of the iris and sclera, and is an involved and time-consuming process.

Because of the great need for artificial eyes, which could not be met by the meager number of persons skilled in the construction of the custom-built eye, commercial optical companies developed the mass-produced stock acrylic resin prosthesis. These eyes may be trimmed and fitted so that they approximate the periphery of the eye socket. The procedure may be done in a very short period of time; it is rapid, but the results are not entirely satisfactory.

These eyes are supplied in three basic shapes: oval, standard, and three cornered. Each shape has three sizes: small, medium, and large. Each may be prepared for the right or the left eye (Fig. 1).

The irides are produced in the three basic colors: brown, hazel, and blue. The individual colors have been formulated so that they have some elasticity and overlapping quality in matching effects. The scleral colors are also varied. One basic size of iris (11.5 mm.) is used, and it has a pupil opening of 3.5 mm. To be made more satisfactory to the patient, the stock eye should therefore be modified to duplicate as closely as possible the superior fit and esthetics of the custom eye. These data pertain to the products of one manufacturer.

## USES

The customized stock acrylic resin eye has several advantages: (1) The adaptation may be accomplished without the aid of an artist or person skilled in the art of iridal and scleral painting. (2) The prosthesis may be fabricated rapidly and positioned to serve the patient as a comfortable and esthetic prosthesis while he is

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The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

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*Resident, Somatoprosthesis, U. S. Naval Dental School.

**Head, Prosthodontics Division, U. S. Naval Dental School.

waiting for his custom-built ocular prosthesis. (3) The prosthesis may be constructed with materials and equipment normally found in any dental office and laboratory, with the exception of the stock eye.* (4) The prosthesis may be used as a conformer or stent immediately postoperatively to aid in the regrowth and orientation of the tissues in the surgical area.

Fig. 1.

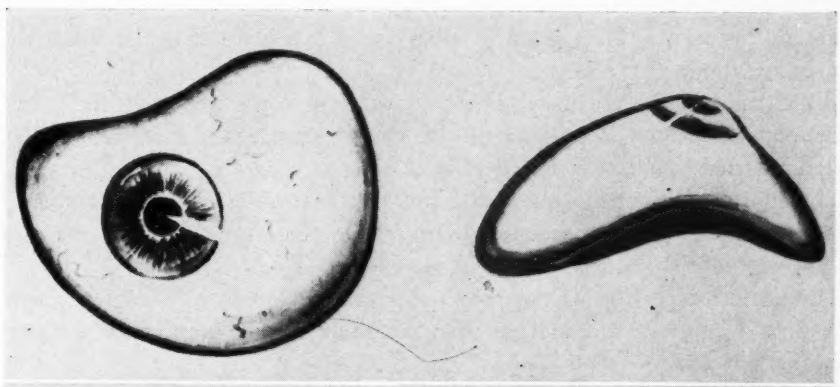

Fig. 2.

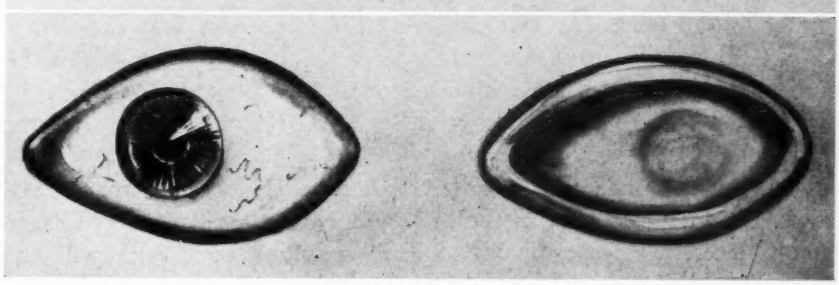

Fig. 1.—A standard stock eye in front and lateral aspects.
Fig. 2.—A reduced stock eye, anterior and posterior views.

## THE TECHNIQUE EMPLOYED

At the patient's first appointment, he is seated in the dental chair. The surgically prepared eye socket is examined for the degree of healing, for mobility of the stump, and for the possibility of need for more surgery. His medical record is inspected at this time and his psychological attitude toward the wearing of an ocular prosthesis is evaluated. The patient is reassured as to the esthetic result and is convinced that there is no pain or discomfort in the procedure.

For the average patient, this first appointment should be about four weeks following operation.

## PREPARATION OF THE STOCK EYE FOR THE IMPRESSION

After the patient is evaluated, a stock eye is selected which matches as closely as possible the coloring of the iris and sclera of the remaining eye. In general shape and size, it should, if possible, resemble the shape and size of the prepared socket.

*Stock acrylic resin eyes may be obtained from most of the commercial optical companies.

After the operator selects the proper stock eye, a cubic centimeter trimmer is used to reduce the complete periphery of the acrylic resin eye. The periphery is then polished with pumice and whiting, and is washed with lukewarm water and mild soap. The reduced eye is then placed in the socket. It must be free of the periphery of the socket in all dimensions, and must cause no distortion or displacement of the tissues.

If further reduction of the periphery and anterior surface is necessary, it should be done at this time. The operator should take care to polish and wash the eye before each "try-in."

When the reduced stock eye is accommodated to the socket to the operator's satisfaction, the posterior portion of the eye is prepared. For this purpose, a mounted inverted cone stone is used (Fig. 2).

This posterior preparation is for the purpose of establishing a mechanical means of retaining the impression alginate on the posterior portion of the modified eye.

The posterior portion of the eye is cut concavoconvex to a depth of approximately 3 to 4 mm. with a margin approximately 2 to 3 mm. from the reduced periphery.

The bottom of the concavity is made convex to provide bulk of sclera under the iris. The operator is *cautioned* not to penetrate through to the iris or the surface of the sclera when cutting with his stone. The periphery of the concavity is then undercut at a bevel of approximately 30 degrees to provide a more positive retention.

An orangewood stick approximately 2½ to 3 inches long is then attached with sticky wax over the *pupil* of the eye. The stick must be centered exactly on the pupil and directly perpendicular to it. The orangewood stick will serve as a tray handle, and also as a means of correlating the line of vision of the modified stock eye with that of the patient's normal eye. The procedure will be described in more detail with the description of the impression.

## THE IMPRESSION

The patient is positioned directly upright in the chair and coached in maintaining a fixed gaze on a point directly in front of him and in a midline position. A piece of tape placed on the wall at the desired spot will aid the patient in maintaining the correct line of vision. He is cautioned about moving the eye or blinking during the four to six minutes necessary for the setting of the impression material. He is again reassured that there will be no pain or discomfort and that the alginate will merely feel cool to the mucous membrane of the socket. Anesthesia is not considered necessary and is not used except in uncooperative children and hyperapprehensive individuals. A mild topical Pontocaine (0.5 per cent) is sufficient in these cases. No lubricant is necessary.

A thin mix of a fine alginate is prepared according to the manufacturer's directions.* It should have good flow and body.

*D.P. Impression Alginate or Jeltrate has been used with excellent results by the authors.

The mixed alginate is applied to the prepared posterior portion of the stock eye (Fig. 3). Any excess lacrimal fluid in the socket is gently removed with a piece of sterile gauze.

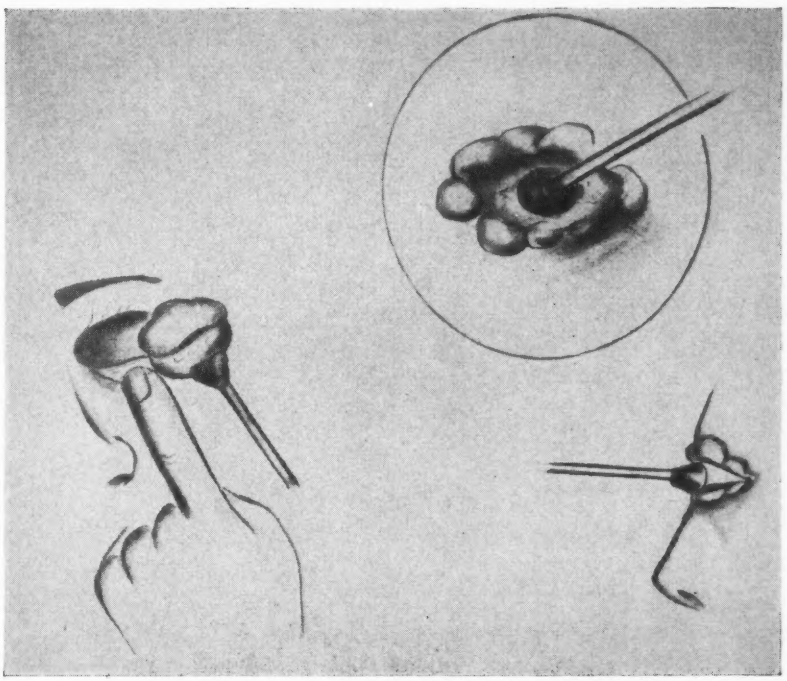

Fig. 3.—The technique of making the impression.

The trimmed artificial eye, which is serving as a tray for the alginate, is then carried to the socket. Insertion may be facilitated if the palpebrae are held apart by the assistant and the tray with the impression material is slipped between them. The alginate is then manipulated gently so that it flows to all portions of the socket. Care must be taken by the operator not to entrap air bubbles. The patient is cautioned again to maintain a fixed gaze on the preselected point and not to move the eye. By means of the orangewood stick, the vertical and horizontal planes of the attached modified eye are correlated with the fixed plane of the gaze maintained by the patient's normal eye. *During all procedures, the utmost care must be taken by the operator to stay away from the patient's normal eye!* Remember, he has only one eye remaining. The assistant should be trained and cautioned by the operator against moving across the patient's line of vision, for any such movement may cause the patient to move his eye.

When the alginate has hardened, removal may be facilitated by gently manipulating the tissues from the alginate and utilizing the attached stick. The eye and impression may be drawn outward and toward the nose.

The impression is checked for air bubbles, and is compared with the socket to see that all areas correspond. If discrepancies are noted such as distortion

or undue tissue displacement from improper consistency of the alginate or large air bubbles, the impression material may be removed and the procedure repeated.

If the impression is found to be accurate, the excess material is trimmed from the anterior portion of the eye to the exact periphery established on the prepared stock eye (Fig. 4).

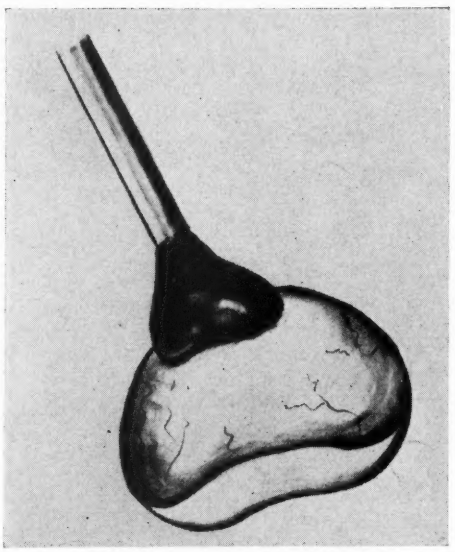

Fig. 4.—The trimmed impression.

The margin between the alginate and the acrylic resin is then sealed with soft utility wax. The seal should be flush, with no bead. At this stage, the orangewood stick and sticky wax are removed, and the impression with the eye attached is placed back in the socket. The position of the iris and the size of the palpebral openings are compared with those of the normal eye. Any protrusion or retrusion as compared with the normal eyes is also checked at this time.

If a serious discrepancy is noted during this check, the most efficient and simple manner of correction is that of repeating the impression procedure.

## INVESTMENT PROCEDURE

The impression and attached eye are then invested in the lower half of a denture flask. A small two-section flask is preferred, if it is available (Fig. 5).

The impression is painted with a mix of stone and placed, alginate down, in the lower half of the flask. The stone investment is brought up to the periphery of the acrylic resin. The stone must be *exactly* on this periphery. After the stone has hardened, it is lubricated with sodium silicate or other suitable clear, nonpigmented, clean separator and the top half is poured in stone.

After a suitable setting period for the stone, the flask is separated (heat is not necessary), and the alginate is removed from the stone investment. The prepared acrylic resin eye is cleaned of any alginate or wax remnants, and is repositioned *exactly* in the upper half of the flask.

Because of the smooth oval or round concavity in the stone investment left by the anterior portion of the stock eye, it is difficult to reposition the eye in the concavity and retain it there during the trial packing and processing of the acrylic resin. It is necessary, therefore, to mark the eye in relation to the concavity. This is done easily with a straight edge and pencil, by marking three lines across the stone and the posterior periphery of the eye. The lines on the stone should be extended to the rim of the flask (Fig. 6).

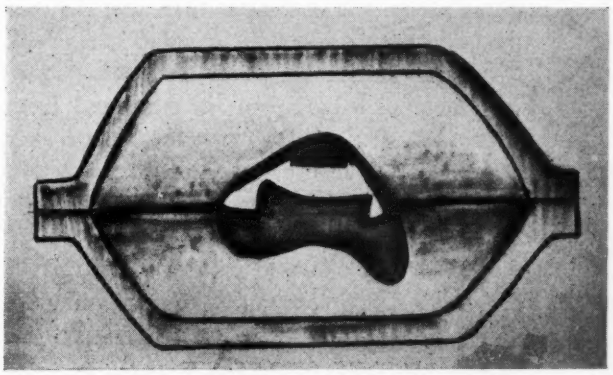

Fig. 5.—The flasked impression in sagittal section.

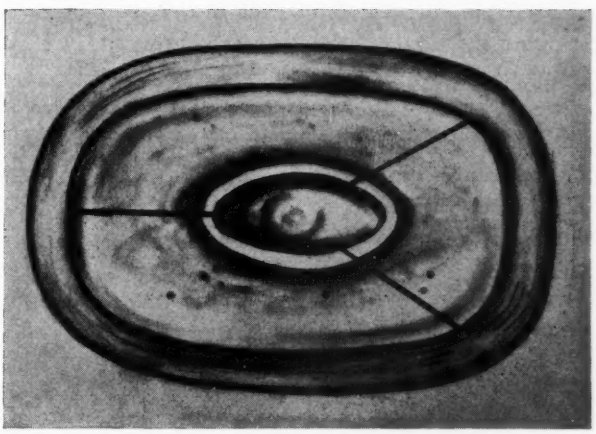

Fig. 6.—The eye in the flask with pencil markings for reseating it.

The processing acrylic resin used is a clear methyl methacrylate. Therefore, the preferred separating medium is pure tin foil. The tin foil is adapted to both halves of the mold.

## PROCESSING THE EYE

A good grade of clear methyl methacrylate resin is mixed in a clean jar. When the resin will no longer stick to a clean spatula, it is ready to pack. The

upper half of the flask (the posterior portion of the eye) is packed level, with no more than finger pressure. A piece of cellophane placed over the finger when manipulating the acrylic resin will prevent contamination. The lower half of the flask is also packed flush with the stone surface. A double thickness of cellophane is placed between halves of the flask, and the flask is closed in a flask press for trial packing. The flask is opened and the flash is trimmed away. Trial packing may be repeated until the correct amount of acrylic resin is evident. The flask is then closed and placed in a flask press for processing.

The press is placed in water at room temperature, and the temperature raised at the rate of 1.8° F. per minute until the boiling point is reached. The press is then boiled for one half to one hour.

After the processing is completed, the eye is recovered from the flask, the stone and tin foil are removed, and the acrylic resin flash is carefully removed with a cubic centimeter trimmer. The eye is then polished with flour of pumice and whiting on a bench lathe. A very slow speed should be used on the lathe to prevent burning or removing an excess of the acrylic resin. After being polished to a high gloss, the eye is thoroughly cleansed with a brush, mild soap, and water. The eye may be sterilized in a 1:1,000 *solution* of benzalkonium chloride.

## DELIVERY OF THE EYE

The prosthesis is inserted in the patient's eye socket, and he is instructed in the use and care of the eye. If this is his first prosthesis, he is given instruction on inserting it. He is told to raise the upper eyelid with his opposite hand, insert the prosthesis, and manipulate the lower lid over it. He is encouraged to practice the insertion and removal before a mirror.

He is told to remove the prosthesis once a day, if necessary, and to wash it under warm water with a soft clean cloth and mild soap. He is cautioned to keep the eye moist by placing it in water if it is not in the eye socket, and never to allow it to come in contact with alcohol, or solvents of any kind. He is cautioned not to allow the prosthesis to become scratched by carrying it in his pocket or purse. He is also told to have the eye repolished if it becomes scratched in any way.

## CONCLUSION

The procedures for fabricating the customized stock acrylic resin ocular prosthesis are similar to those performed by the dentist, and recommend themselves for his consideration as an added service to his patients.

U. S. Naval Dental School
National Naval Medical Center
Bethesda, Maryland

# Readers' Round Table

CHICAGO, ILL.

EDITOR, THE JOURNAL OF PROSTHETIC DENTISTRY:

I notice in an article by John P. Frush and Roland D. Fisher, entitled "Introduction to Dentogenic Restorations," (J. PROS. DEN. 5:586-595, 1955) the authors attempt to justify this neologism in the following:

" 'Dentogenic' is a coined word meant to convey, in reference to prosthetic dentistry, exactly the same meaning as the suffix *-genic* imports to photograph in the word 'photogenic.' Precisely, according to Webster's dictionary, that means, 'eminently suitable for production or reproduction.' In our word 'dentogenic,' we seek to describe only such a denture as is 'eminently suitable' in that, for the wearer, the denture adds to that person's charm, character, dignity, or beauty in a fully expressive smile. 'Dentogenics,' then, means the art, practice, and techniques used to achieve that esthetic goal in dentistry."

The intrepretation of the term is peculiar. The authors overlook the fact that "photogenic" applies to the person as "producing" an attractive photograph, whereas, in "dentogenic" it is not the person who produces or is suitable for the denture. If "dentogenic" means producing an attractive denture, who or what is "dentogenic?" Moreover, "dento-" is not the combining form for denture. To my mind a "dentogenic restoration" would be a restoration that produces teeth. I had supposed that all dental prosthesis was intended to be esthetic and that it would be unnecessary to have a special branch of prosthetic dentistry devoted to esthetic prosthesis. In other words, the authors are making a requisite of good prosthesis into a specialty.

It seems to me that such thoughtless coinage should be discouraged, and I think that you as an editor could do much to discourage this sort of thing.

Sincerely yours,

GEORGE B. DENTON, D.D.S.
American Dental Association
Research Consultant
Bureau of Library and
Indexing Service

# Book Reviews

PRACTICE ADMINISTRATION FOR THE DENTIST Edited by William R. Mann, M.S., D.D.S., and Kenneth A. Easlick, A.M., D.D.S. 386 pages; Indexed. St. Louis, 1955. The C. V. Mosby Co. Price $8.50

Many of us who can look back two decades or so remember the beginning appearance on dental society programs of lecturers who spoke on "the business side of dentistry" and "dental economics." Some were sincere and successful practicing dentists; others were commercial dental businessmen; a few were dental racketeers. In time, their number increased and their theme became "practice management." More recently the subject has been broadened into "practice administration" with a corresponding widening of scope and responsibility, and has been seasoned with a growing awareness of the more basic principles and general economic conditions involved.

It is encouraging to note the widespread interest in the administration of private dental practice by educators, organizations, and practitioners. This book, a pioneering effort, certainly reflects that growth and development.

In September, 1953, the W. K. Kellogg Foundation Institute for Graduate and Postgraduate Dentistry of the University of Michigan, sponsored a week-long workshop to study the organization of private practive for the extension of scientific dental health service to a greater number of people. The 207 dentists, dental hygienists, dental assistants, and dental educators enrolled were from 31 states, the District of Columbia, and 4 provinces of Canada; faculty representatives from 26 dental schools were in attendance. This book is a collection of the papers presented by the qualified lecturers, the discussions of the papers, and the material prepared by the several evaluating committees. Actually it is the transactions of the workshop.

Eight broad aspects of practice organization and administration are considered: ethics and community responsibility; problems and methods of providing more dental care; organizing a new practice; auxiliary personnel; fees, accounting methods, and office routine; methods of payment; and patient education.

Each of these divisions is ably presented, widely explored, and intelligently discussed. The data, findings, and conclusions established by this workshop are presented most adequately and in a form easy for study and assimilation.

The practitioner, in any type of community and in any stage of practice, will discover much useful information to aid him in improving his service and in determining a better pattern of practice. The just-graduated dentist, confronted with the awesome problems of beginning practice, will find here most of the solutions; the business aspects of selecting an office, equipping it, and organizing it efficiently are all here to help him in his earliest decisions. Finally, the teacher will find considerable material and background to enable him to organize and present needed courses of instruction in this basic subject to the end that practice administration will be brought to its rightful position in the undergraduate curriculum.

This is a good book; it is deserving of, and undoubtedly will find, a wide dental audience. It is likely that dental librarians will have difficulty keeping enough copies on their "new books" rack.

T. F. McBride

PARTIAL DENTURES. By John H. Wilson, D.D.Sc. (Syd.) Pp. 294 with 193 photographs and live drawings; indexed. Sydney, Australia, 1955, Angus and Robertson, Ltd.

This book deals with the various phases of partial denture construction from diagnosis and treatment planning to the completed denture. A vast amount of experience and an extensive study of current literature makes this book of value to students as well as the general practitioner, the purpose for which the text was written.

The organization and chapter continuity is quite logical; this together with the index permits for ready references. In addition there are chapters on preventive dental service, one chapter where particular stress is laid on the basic biologic and radiographic factors, separate chapters devoted to diagnosis, impressions, the laws of occlusion, retention, general principles of design, technology, clinical procedures, and treatment of various cases.

Although the Kennedy classification of partial dentures is used, the author recognizes that a universally accepted classification is greatly needed. This book is well illustrated with black and white photographs and drawings which are marked to assist the reader. In the opinion of this reviewer this book is a valuable reference.

John O. Neufeld

THE DENTIST AND THE LAW, Charles Wendell Carnahan, Ph.B., J.D., LL.M., Jur. Sc.D. First Edition, 263 pages, indexed. St. Louis, 1955, The C. V. Mosby Company. Price $5.25.

This is an excellent book, concise, well arranged, clear in presentation, and thorough in the treatment of its subject. The introductory chapter devotes twenty-five pages to "The Nature of Law and Types of Law," "Judicial Machinery," and "Principles of Ethics of the American Dental Association," a very practical explanation of fundamentals and an invaluable preparation for the ensuing chapters.

Chapter 2 develops admirably the respective duties of doctor and patient, including the rules relating to negligence and contributory negligence.

Chapter 3, "Compensation for Dental Services in General," and Chapter 4, "Compensation for Dental Services as to Particular Persons," recite and analyze the general principles of contract law, expressed provisions by patient and dentist, promises between third party and dentist, implied provisions as to payment liabilities of husband, wife, parent and minor, and claims for payment against estate of deceased or bankrupt.

Chapters 5, 6, and 7 treat the subject of malpractice exhaustively, including the applicable special rules of evidence and malpractice defenses. In simple factual form they cover anesthetics, x-rays, consent to treatment, res ipsa loquitur, releases, and statutes of limitations.

Chapter 8, "Liability for the Acts of Others," brings into sharp focus the relationship of master and servant, principal and agent, and partners.

Chapter 9, "Injury to Those Other than Patients," is very informative. Liability for injury with and without consent, death resulting from wrongful act, injury to office assistant, and infection spread by patient are explained directly and inclusively.

Chapter 10, "The Dentist as a Witness," describes his duties as a lay witness or expert, compensation, preparation for testimony, examination and cross examination, and the use of professional literature.

The author concludes his book with a "Table of Cases Cited," enabling the reader to follow the citations to a reading and study of the entire case as published in the court reports indicated.

This book is extremely valuable as a text for the student and as a reference volume for the practicing dentist. It translates abstract thought or concept of dental jurisprudence to definite understanding. Each of its 179 sections is commendably clear, due in large part to the writer's avoidance of technical terms wherever possible. The choice of illustrative cases also adds greatly to the clarity of the work. Comprehensive and completely up to date, "The Dentist and the Law" is an outstanding contribution to the literature of its field.

Neal A. Harper

## FOURTH ANNUAL ESSAY CONTEST

*Sponsored by*

## THE AMERICAN DENTURE SOCIETY

PRIZES WILL BE AWARDED to the two senior dental students who submit the best essays on prosthetic dentistry in the fourth annual essay contest sponsored by The American Denture Society. The purpose of the contest is to stimulate technical writing by dental students.

The first prize is Five Hundred Dollars ($500.00) and the second prize is Three Hundred Dollars ($300.00).

### RULES

1. The contest is open to all senior dental students in the dental colleges of the United States and Canada.
2. Only two essays may be submitted from any one dental college. (It is recommended that each dental college conduct its own contest to determine the two best essays submitted by members of its senior class.)
3. All essays submitted in the contest shall be accompanied by a letter from the professor of prosthetic dentistry and/or the dean of the dental college from which they originate. This provision is to assure the authenticity of all essays entered in the contest.
4. For this year's contest, essays must be postmarked on or before July 15, 1956.
   It is recommended that students start preparing their essays by the middle of their junior year and complete them by the middle of their senior year.
5. Essays are to be on some phase of prosthetic dentistry, and limited to a maximum of 2,500 words.
6. Essays must be worthy of publication in the JOURNAL OF PROSTHETIC DENTISTRY.
7. Essays must be typewritten, double spaced, on a good grade of white bond paper 8½ by 11 inches. No carbon copies or essays on onion skin paper will be considered. Paragraphs must be indicated clearly by indentations, and generous margins must be allowed on each page.
8. Illustrations must conform to the standards of the JOURNAL OF PROSTHETIC DENTISTRY, if they are used. Only good glossy black and white photographic prints or drawings in India ink may be used. Each illustration should be mounted on a separate sheet of paper with the figure number and the legend typed on the paper beneath the illustration.

9. References must conform to the style used in the JOURNAL OF PROSTHETIC DENTISTRY.
10. Essays are to become the property of The American Denture Society. None will be returned.
11. The judges of the contest are members of a committee of The American Denture Society. The decision of the judges is final.
12. Essays are to be clearly marked "Contest Essay" and sent, with a letter from the professor of prosthetic dentistry or the dean of the dental college indicating that this essay is an official entry from the dental college, to:

Dr. Victor L. Steffel
Secretary-Treasurer, American Denture Society
College of Dentistry, Ohio State University
Columbus 10, Ohio.

# News and Notes

## ANNOUNCEMENTS

The Annual Meeting of the Pacific Coast Society of Prosthodontists will be held at the Arizona Biltmore Hotel, Phoenix, Ariz., March 29 to 31, 1956.

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The Annual Meeting of the Academy of Denture Prosthetics will be held at the Broadmoor Hotel, Colorado Springs, Colo., April 30 to May 5, 1956.

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The third annual meeting of the Southeastern Academy of Prosthodontics will be held at the Atlanta Biltmore Hotel in Atlanta, Ga., March 17 and 18, 1956. For further information, write to Dr. Walter A. Hall, Jr., P.O. Box 115, Loyola University, New Orleans, La.

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The next scientific meeting of the Deutsche Gesellschaft fuer Kiefer-und Gesichtschirurgie will be held from May 28 through May 30, 1956, at Munich, Germany.

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The Veterans Administration Hospital, Iowa City, Iowa, in affiliation with the State University of Iowa College of Dentistry, announces that two rotating dental internships and one residency in Prosthetics will be available for the year beginning July, 1956. Application material and information may be obtained from the Chief, Dental Service, VA Hospital, Iowa City, Iowa.

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The University of Alabama School of Dentistry in conjunction with the Birmingham Veterans Administration Hospital offers a two-year residency in Prosthetics, which can lead to the Master of Science degree in Dentistry, if desired. Applicants, due to Veterans Administration regulations, must be American citizens.

For detailed information, write to Joseph P. Lazansky, M.D., D.M.D., Associate Dean, Director of Graduate and Postgraduate Education, University of Alabama School of Dentistry, Birmingham 3, Ala.

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The Medical College of Virginia, School of Dentistry, announces a series of postgraduate courses of interest to general practitioners.

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| Anatomy of the Head and Neck | March 19 to 23, 1956. |
| Oral Surgery | April 9 to 11, 1956. |
| Roentgenology | April 16 to 18, 1956. |

For further information, write to S. J. Kreshover, Director of Postgraduate and Graduate Instruction, Medical College of Virginia, School of Dentistry, Richmond 19, Va.

New York University College of Dentistry announces two postgraduate courses in Periodontia and Oral Medicine, by Dr. Samuel Charles Miller and Staff.

No. 123—Periodontia and Oral Medicine in the Spanish Language, April 2 to 27, 1956.

No. 122—Comprehensive Preparation in Periodontia and Oral Medicine. This program is arranged in from one to four academic years.

The Department of Periodontia and Oral Medicine of New York University College of Dentistry also announces its Annual Workshop on "Occlusal Equilibration" to be held June 11 to 15, 1956. For further information, write to the Secretary, Postgraduate Division, New York University College of Dentistry, 209 East 23rd St., New York 10, N. Y.

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Northwestern University announces fifteen short postgraduate courses to be given during the academic year 1955-1956. Courses in Operative Dentistry, Oral Surgery, Periodontia, Orthodontics, Pedodontics, Crown and Bridge, Pathology, and Histology are included, as well as specific courses in diagnosis and medical problems in relation to dentistry. The courses will be given by prominent dental teachers from the faculties of Northwestern University Dental School and other well-known dental schools, and by prominent clinicians.

The dates of the courses and other detailed information can be obtained by addressing the Director of Dental Postgraduate Study, Northwestern University Dental School, 311 E. Chicago Ave., Chicago 11, Ill.

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The School of Dentistry, University of Pennsylvania, announces the following postgraduate courses:

Complete Denture Prosthesis, Victor O. Lucia, March 19 to 24, 1956.

Endodontics, Louis I. Grossman, April 12 to 27, 1956.

The Seventh Mid-Atlantic States Conference in Dentistry, Skytop Lodge, Skytop, Pa., Periodontal Prosthesis, Lester W. Burket, April 22 to 27, 1956.

For further information concerning these courses, please communicate with Postgraduate Courses, School of Dentistry, University of Pennsylvania, Philadelphia 4, Pa.

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Temple University School of Dentistry announces a four-day participating postgraduate course, "Occlusion and What To Do About It," to be given under the direction of Bernard Jankelson on May 3 to 6, 1956. For further information, write to Dr. Louis Herman, Director of Postgraduate Studies, Temple University, School of Dentistry, 3223 North Broad St., Philadelphia 40, Pa.

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The Dental Department of Beth Israel Hospital in Boston announces a postgraduate course in Periodontia.

Seminar in Periodontia, May 7 to 18, 1956.

For further information, write to Coordinator of Education Programs, Beth Israel Hospital, 330 Brookline Ave., Boston 15, Mass.

The Ohio State University College of Dentistry announces a series of postgraduate courses to be presented during the 1955-1956 school year. The enrollment of each course is limited, in order to permit intimate teaching.

The schedule of these postgraduate courses is as follows:

Anatomy of the Head and Neck, Dr. Linden F. Edwards, June 11 to 15.

Clinical Periodontics, Dr. John R. Wilson, June 11 to 15.

Complete Denture Prosthodontics, Dr. Carl O. Boucher, April 9 to 13.

Crown and Bridge, Dr. Frank C. Starr, April 2 to 6.

General Anesthesia, Dr. M. L. Allison and Staff, May 21 to 25.

New Advances in Restorative Dentistry, Drs. William Lefkowitz, Harry Postle, and Mr. Ralph Phillips (Indiana University), May 10 to 12.

Oral Surgery, Dr. M. L. Allison and Staff, April 30 to May 4.

Partial Denture Prosthodontics, Dr. Victor L. Steffel, March 26 to 30.

Pedodontics, Drs. L. S. Pettit and Ben Williams, May 14 to 18.

Periodontology and Soft Tissue Lesions, Drs. Hamilton B. G. Robinson and John R. Wilson, June 4 to 8.

For further information and application, write to Postgraduate Division, College of Dentistry, Ohio State University, Columbus 10, Ohio.

# The Journal of Prosthetic Dentistry

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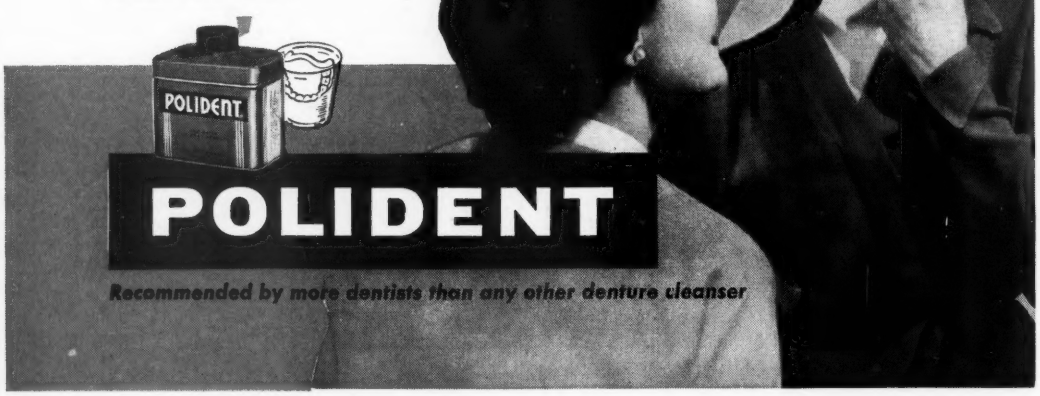


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